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A PREVIOUSLY UNDESCRIBED PANDOREA FROM NORTHEAST QUEENSLAND, AUSTRALIA

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Plate 35

Pandorea nervosa Van Steenis, n. sp.

Pandoreae jasminoidi similis sed foliis utrinque reticulato-venosis, nervis venisque utrinque prominentibus, calyce in alabastro clauso deinde irregulariter in lobis rumpente, corolla infundibuliforme, albida, tubus intus secus basin pallide flavescente, lobis minoribus differt.

Vine with slender, ribbed, purple stems minutely puberulous towards the top. Leaves with 5 leaflets, those immediately below the thyrse reduced to 3 leaflets; petioles 1.5–3.5 cm. long, slightly sulcate towards the tip as the rhachis, the bases of each pair connected with a prominent rim; rhachis ca. 2 cm. long; petioles of the lateral leaflets sulcate and winged by the decurrent margin of the blade, 2–5 mm. long, articulated at the insertion, those of the terminal leaflet (in the 2-jugate leaves) 1–1.5 cm. long, those in the 1-jugate leaves nearly sessile on and articulated with a stalk (rhachis) 1 cm. long. Leaflets dark green, ovate to ovate-oblong, the base rounded or rather cuneate, decurrent along the petiole, the tip rather abruptly acutely acuminate or even shortly caudate (acumen up to 1 cm. long), blade mostly oblique, 2.5–6 cm. long and 1.5–4 cm. broad; margin entire or with 1–2 crenate teeth on each side below the acumen; midrib sulcate above, rather strongly prominent below; primary nerves 5–7 pairs and a few smaller ones in the acumen, curved upwards towards and along the margin and united in a looped line, when dry prominent on both sides as are the numerous reticulations; glands impressed on the upper surface, dark-colored and not immersed below. Peduncle terminal, protruding ca. 2 cm. above the reduced upper leaves, as long as the rhachis. Thyrse minutely puberulous throughout, dense-flowered; lateral stalks opposite, the lower ones ca. 5 mm. long, 3-flowered, the upper ones (sometimes all in the poorer specimens) 1-flowered. Bracts acute-triangular, 1–1.5 mm. long, the bracteoles smaller.

Pedicels 3–6 mm. long, articulated below the thickened obconical hypanthium supporting the calyx. Flowers odorless, showy. Calyx glabrous, closed in bud with indistinctly indicated lobes, later on irregularly split into lobes up to 2.5 mm. high, campanulate, 6–7.5 mm. high (measured from the articulation). Corolla white, the tube with yellow inside near the base, infundibuliform, slightly curved, ca. 3.5 cm. long (excluding the lobes), puberulous-papillose outside, the slightly inflated broad base glabrous, the lower half of the tube inside long-pubescent at the side of the fertile stamens, glabrous at the opposite side near the staminodium; lobes 5, slightly unequal, broadly rounded, suborbicular, 7–9 mm. high, 7–11 mm. diameter, papillose-puberulous on both surfaces. Stamens 4, the smaller ones on filaments about 7 mm. long, inserted about 6 mm. above the base of the tube, the filaments of the longer ones 12–13 mm. long, inserted at about 9–10 mm. height, all glabrous except at their glandular-hairy insertion. Anthers divergent, linear-oblong, rather blunt, 3.5 mm. long, the connective indistinctly protruding above the cells. Staminodium small, curved, linear. Disk entire, annular-cupular, surrounding the base of the ovary. Ovary oblong, 6 mm. high, more or less terete, 2-celled, each cell with several rows of ovules, each row with 10–15 ovules; style linear, ± 1.5 cm. long, stigma with 2 blunt spathulate lobes. Dissepiment bearing 2 prominent placentas in each cell. Fruit unknown.

NORTH QUEENSLAND: Ghurka Pocket, Boonjie, Atherton Tableland; common in rain-forest, 700 m. alt., *S. F. Kajewski*, no. 1227 (Arnold Arb. Exped.), Sept. 24, 1929 (vine growing over small trees, leaves dark green, stems purple, flower white with light yellow inside near the base, very showy but no perfume).

This is the fourth Australian species of *Pandorea*. It is allied to *P. jasminoides* K. Schum. and can be inserted into the key given in my monograph of the Australian Bignoniaceae (Proc. Roy. Soc. Queensland, XLI. 39–58. 1928) as follows:

1a. Corolla large, 4–5 cm. long, outside papillose-puberulous.....1b.
Corolla 1–1.5 cm. long, glabrous outside.....2.

1b. Corolla white with light yellow inside near the base of the infundibuliformous tube, the lobes suborbicular, ca. 1 cm. in diameter. Calyx 6–7.5 mm. long, closed in bud, later on split irregularly into lobes up to 2.5 mm. long. Leaflets ovate to ovate-oblong, distinctly and mostly abruptly acute-acuminate, the nerves and reticulations distinctly prominent.....*P. nervosa.*

Corolla creamy or pale rose, streaked with carmine in the throat, the tube hypocraterimorphous, the lobes suborbicular, ± 2 cm. in diameter. Calyx 5–6 mm. high, open in bud, remaining truncate. Leaflets oblong to lanceolate, rarely some ovate, with a blunt, gradually tapering tip, the nerves and reticulations not or slightly visible. *P. jasminoides.*

A prominent nervature is known in *Pandorea* only in the entirely different *P. stenantha* Diels from New Guinea and *P. Baileyana* Van Steenis from New South Wales. The form of the corolla is the same as in *Tecomanthe* and the lobed, large calyx is aberrant in *Pandorea;* the corolla-tube, however, being long-pubescent on the anterior side and the inflorescence being a thyrse (not a raceme as in *Tecomanthe*) I found it advisable to refer it to *Pandorea.* For the rest I have already pointed out elsewhere (Bull. Jard. Bot. Buitenzorg, sér. 3, x. 202. 1928) that there seems to be no important difference between *Pandorea, Tecomanthe* and *Campsis* but I feel not competent to unite these genera as I had no opportunity to make a closer study of *Campsis,* this being the oldest genus described.

As appears from the key *P. nervosa* is related to *P. jasminoides* K. Schum., the latter species having no large range of variability as contrasted with *P. pandorana* Van Steenis which is exceedingly variable.

I do not know the description of *Tecoma doratoxylon* J. M. Black (Transact. & Proc. Roy. Soc. S. Austral. LI. 383. 1927) because this periodical is not accessible to me but I suspect that it will be another species of *Pandorea* or *Tecomanthe.*

HERBARIUM, BUITENZORG
JAVA

NOTULAE SYSTEMATICAE AD FLORAM SINENSEM, III

H. H. HU

Fagus lucida Rehder & Wilson in Sargent, Pl. Wilson. III. 191 (1916).

Descriptioni adde: Involucrum 6–9 mm. longum, fulvo-tomentulosum, extus squamis adpressis deltoideis brevissimis acutis munitum, nuculis exsertis fulvo-sericeo-pubescentibus 9 mm. longis, pedunculo gracili 1 cm. longo glabro suffultum.

Involucre 6–9 mm. long, tawny-brown-tomentulose, with very short appressed acute deltoid scales on the outside, nut exserted, tawny-sericeous-pubescent, 9 mm. long; stalk slender, 1 cm. long, glabrous.

KWANGSI: Dar Young Kiang, Luchen, border of Kweichow, 1300 m., *R. C. Ching,* Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 6272, June 27, 1928.

The specimen collected in Kwangsi agrees exactly with the type from Hupeh in the leaves having sinuate margins with secondary

veins projecting from the bases of the sinus forming triangular teeth, but differs in the midribs and secondary veins beneath being glabrous, while the midribs above are pilose.

It is very satisfactory to have been able to collect the fruits and to publish a supplementary description of this interesting species which Rehder & Wilson first published fourteen years ago based on sterile specimens. This species is striking also in the involucre being covered not with recurved prickles but with very short appressed deltoid scales, a character very rare in the genus *Fagus*, which easily differentiates this from all other eastern Asiatic species. It is very common in the woods on the top of Dar hills above Dar Young Kiang.

Hydrangea kwangsiensis, sp. nov.

Frutex 1 m. altus, ramulis gracilibus teretibus glabris. Folia membranacea, oblanceolata vel lanceolata, 7–10 cm. longa et 1.8–2.8 cm. lata, acuminata, basi cuneata et decurrentia, margine leviter revoluta et satis remote minuteque callosa-denticulata, glabra, supra laete viridia et costa leviter elevata, subtus pallide viridia, costa magis elevata et venis lateralibus curvatis vix distinctis; petioli 8–10 mm. longi, glabri. Cymae planae, satis multiflorae, ad 14 cm. longae et 8–9 cm. latae, longe pedunculatae pedunculo circiter 5 cm. longo gracili, radiis 3–5 oppositis, basi bracteis parvis foliaceis suffultis, axibus pedicellisque minute crispulo-villosis; pedicelli graciles, 1.5–2 mm. longi; flores steriles pauci, sepalis 4 albis rhombico-ovatis vel suborbicularibus 11 mm. longis latisque ad marginem crispatis; flores fertiles coerulescentes, tubo calycis turbinato minute hispidulo, dentibus triangularibus, petalis late ovatis apice rotundatis 2 mm. longis, staminibus 10 subaequalibus quam petala brevioribus; ovarium semi-superum; styli 3 recurvi. Fructus ignotus.

Shrub to 1 m. high; branchlets slender, terete, glabrous. Leaves membranaceous, oblanceolate to lanceolate, acuminate, cuneate and decurrent at base, slightly revolute and rather remotely and minutely callose-denticulate, glabrous, light green and with slightly elevated midrib above, pale green and with more prominently elevated midrib and very faint lateral arching veins beneath, 7–10 cm. long, 1.8–2.8 cm. broad; petiole glabrous, 8–10 mm. long. Cymes flat, many-flowered, to 14 cm. long, about 8–9 cm. broad, composed of 3–5 opposite radii with small leafy bracts at the base, long-peduncled with the peduncle about 5 cm. long, rachis of the cyme and pedicels minutely crisp-villose; pedicels slender, 1.5–2 mm. long; sterile flowers few, sepals 4, white, rhombic-ovate to suborbicular, crisp along the margins, 11 mm. long and broad; fertile

flowers bluish; calyx turbinate, minutely hispidulous, teeth triangular; petals broadly ovate, rounded at apex, 2 mm. long; stamens 10, subequal, shorter than the petals; ovary half-superior, style 3, recurved. Capsule unknown.

KWANGSI: Chu-feng Shan, north of Luchen Hsien, on border of Kweichow, alt. 800 m., very common in woods or in open thickets, *R. C. Ching*, Kwangsi Exped. Metrop. Mus. of Nat. Hist. Acad. Sin. no. 5386 (type), June 8, 1928.

A species of the section Euhydrangea, allied to *H. yunnanensis*, Rehd. differing in the leaves being minutely callose-denticulate and with very faint lateral veins, in the long-peduncled cyme and in the smaller sterile flowers.

Citrus kwangsiensis, sp. nov.

Arbor ad 10 m. alta, trunco 25 cm. diam., cortice viridi-cinereo; ramuli longi, irregulariter angulati, striati, lenticellis sparsis ovalibus muniti, sparse pilosuli, virides; spinae validae, pungentes, 8–12 mm. longae. Folia coriacea, elliptico-oblonga, 9–15 cm. longa et 4–6.5 cm. lata, apice obtusiuscula, basi late cuneata vel rotundata, irregulariter dupliciter adpresseque crenulato-serrulata, glabra, supra intense viridia et venis non prominentibus, subtus pallide viridia, et venis elevatis reticulata; petioli articulati, anguste alati, 12–15 mm. longi, sparse pilosuli. Flores ignoti. Fructus immaturus ovoideus, leviter obtuse apiculatus, 3–5 cm. diam., 13-locularis, cortice 11 mm. crasso glabro, pulpa exigua 1.5 cm. diam.; fructus maturus 7 cm. diam., luteus (fide collectoris).

Tree to 10 m. high, 25 cm. in diam.; bark greenish-grey; branches long, irregularly angular, striate, with scattered oval lenticels, sparsely pilosulous, green; spines stout, sharp, 8–12 mm. long. Leaves coriaceous, elliptic-oblong, obtusish at apex, broadly cuneate to rounded at base, irregularly doubly and appressed-crenulate-serrulate along the margins, glabrous, intensely green and with non-prominent veins above, paler green and with elevated and reticulate veins beneath, 9–15 cm. long, 4–6.5 cm. broad; petiole articulate to the blade and the twig, narrowly winged, 12–15 mm. long, sparsely pilosulous at base. Flowers unknown. Young fruit ovoid, slightly obtusely apiculate at apex, 3.5 cm. in diam., rind 11 mm. thick, glabrous, pulp scanty, 1.5 cm. in diam., 13-segmented; mature fruit 7 cm. in diam., yellow (fide collector).

NORTH KWANGSI: Hoo-chi, alt. 900 m., cultivated in garden, *R. C. Ching*, Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 6456 (type), June 14, 1928.

A very distinct species apparently related to *C. medica* L. and *C. maxima* Merr. by its fruits having very thick rind, but differing

from the former in the articulated and narrowly winged petioles and from the latter in narrowly winged petioles and much smaller fruits.

Acer angustilobum, sp. nov.

Arbor ad 14 m. alta, trunco 30 cm. diam., cortice cretaceo-albo; ramuli graciles, glabri. Folia chartacea, 3–5-lobata, ad 15 cm. longa et 13 cm. lata, basi cuneata vel subrotundata, lobis lanceolatis longe caudatis apicem versus remote serrulatis, lobo medio ad 6.5 cm. longo et 2.2 cm. lato, lateralibus paullo brevioribus et angustioribus, basalibus parvis ad 1.5 cm. longis, sinubus acutis, lamina utrinque clare et lucide viridi, axillis subtus albido-barbatis exceptis glabra, utrinque reticulato-venulosa; petioli graciles, ad 4 cm. longi, glabri. Inflorescentia paniculata, ad 11 cm. longa; samarae virescentes, alis horizontaliter patentibus, nuculis inclusis 3 cm. longae et 1 cm. latae, basi distincte angustatae, dorso curvatae, nuculis ellipsoideis leviter compressis sublaevibus leviter tantum venulosis, 6 mm. longis et 3.5 mm. latis.

Tree to 14 m. high, 30 cm. in diam.; bark chalky white; branchlets slender, glabrous. Leaves chartaceous, 3–5-lobed, cuneate or subrounded at base, to 15 cm. long, 13 cm. broad, lobes lanceolate, long-caudate at apex, with acute sinuses, remotely serrulate toward the apex, midlobe to 6.5 cm. long, 2.2 cm. broad, lateral lobes slightly shorter and narrower, basal lobes small, to 1.5 cm. long, 7 mm. broad; pale shining green on both surfaces, glabrous except with axillary tufts of whitish hairs beneath, reticulate-venulose on both surfaces; petiole slender, to 4 cm. long, glabrous. Panicles elongated, to 11 cm. long; samaras greenish, with wings horizontally spreading, including the nutlets about 3 cm. long, 1 cm. broad, distinctly narrowed at base and arching at back, nutlets ellipsoid, slightly compressed, rather smooth, only slightly venulose, 6 mm. long, 3.5 mm. broad.

KWANGSI: Chu-feng Shan, north of Luchen Hsien, alt. 630 m., common in woods, *R. C. Ching,* Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 5802 (type), June 8, 1928.

A species of the section Spicata, allied to *A. sinense* Pax and *A. Wilsonii* Rehd., differing from the former in the 3–5 narrow ascending lobes remotely serrulate toward the apex and in the blade being narrowed toward the rounded base and from the latter in the leaves often 5-lobed with two small basal lobes.

Acer oblongum Wall. var. **macrocarpum,** var. nov.

A typo recedit folius subtus minute tomentulosis, corymbo fructibus 4–5, pedunculo permanenter floccoso, samarae ad 4 cm. longae, alis semiorbicularibus 3.2 cm. longis et 1.4 cm. latis, basi

abrupte contractis ad marginem irregulariter erosis, nuculis ad 7 mm. longis.

Differing from the type in leaves being minutely tomentulose beneath, cymes with 4–5 fruits, peduncle persistently flocoose, samara to 4 cm. long with semi-orbicular wings 3.2 cm. long, 1.4 cm. broad, irregularly erose along the margins and abruptly contracted on the lower part, and nutlets to 7 mm. long.

KWANGSI: Tang-Chia-Fu, east of Luchen Hsien, alt. 300 m., rare in woods, *R. C. Ching*, Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 5220 (type), May 23, 1928.

Rhododendron minutiflorum, sp. nov. (§ Tsutsuti)

Frutex erectus ad 2.25 m. altus, ramosissimus; ramuli verticillati, ascendentes, tenues tortuosi, vestigiis fuscis setarum scabridi, juniores strigoso-setosi setis applanatis rubro-fuscis appressis. Folia persistentia, 4 vel 5 in apice ramulorum congesta, crasse chartacea, late obovata vel oblonga, 7–11 mm. longa et 4.5–5.5 cm. lata, basi cuneata, apice breviter acuminate, margine revoluta et minute crenulata, supra obscure viridia et strigoso-setosa, subtus pallide viridia et glabra costa margineque strigoso-setosis exceptis; petiolo strigoso-setosi; ad 2 mm. longi. Flores simul cum foliis novellis, in umbellis terminalibus 3-floris; bracteae minutae, triangulares, acutae; pedicelli strigoso-setosi, ad 2 mm. longi; calyx dense pilis strigosis obtectus et ciliatus, lobis subrotundatis circa 1 mm. longis et 1.5 mm. latis; corolla 7 mm. diam., rotato-infundibuliformis, tubo extus pilis rubescentibus pilosulo intus glabro 2.5 mm. longo, lobis patentibus tubum subaequantibus ovato-oblongis breviter acuminatis 3 mm. longis basi 2.5 mm. latis utrinque glabris non maculatis; stamina 5, subaequalia, exserta, filamentis circa 7 mm. longis triente superiore excepto minute puberulis, antheris oblongis 1 mm. longis; ovarium dense setosum, 2.5 mm. longum; stylus declinatus, 8 mm. longus, rubido-pubescens, stigmate capitato. Capsula ignota.

Erect shrub to 2.25 m. high; branchlets dense, verticillate, slender, tortuous and arching, scabrid with blackened remains of old appressed bristly hairs, young growth strigose-setose with reddish-brown flattened bristly hairs. Leaves persistent, those of this year's growth 4 or 5 crowded at the apex of the branchlets just above those of last year, thickly chartaceous, broadly obovate to oblong, cuneate at base, shortly acuminate at apex, revolute and minutely crenulate and the margins, dark green above and strigose-setose above, paler green and glabrous except densely strigose-setose along the midrib and the margins beneath, 7–11 mm. long, 4.5–5.5 mm. broad; petiole strigose-setose, to 2 mm. long. Flowers

appearing with the leaves, in terminal 3-flowered umbels; bracts minute, triangular, acute; pedicels strigose-setose, 3–4 mm. long; calyx completely covered by and fimbriate along the margins with dense bristly hairs, lobes distinct, roundish, rounded at apex, about 1 mm. long and 1.5 mm. broad; corolla 7 mm. in diameter, rotate-funnel-shaped, tube pilosulous with reddish hairs outside, glabrous inside, 2.5 mm. long, lobes spreading, about as long as the tube, ovate-oblong, shortly acuminate, 3 mm. long, 2.5 mm. broad at base, glabrous on both surfaces, not spotted; stamens 5, subequal, exserted, about 7 mm. long, minutely puberulous on the lower ⅔ of their whole length; anthers oblong, 1 mm. long; ovary completely concealed by dense bristly hairs, 2.5 mm. long; style declinate, pubescent with reddish hairs, 8 mm. long; stigma capitate. Capsule unknown.

This is a very distinct species of the section Tsutsutsi; in its flowers it resembles *R. Seniavinii* Maxim., except that they are much smaller, but the leaves are very different and by their size recall those of *R. serpyllifolium* A. Gray which, however, has entirely different flowers.

KWANGSI: Chu-feng shan, north of Huchen hsien, alt. 1120 m., *R. C. Ching*, Kwangsi Exp. Metrop. Mus. Nat. Hist. Acad. Sin. no. 5860 (type). June 9, 1928.

Porana sinensis Hemsley in Jour. Linn. Soc. XXVI. 167 (1890).
Vatica cordata Hu in Jour. Arnold Arb. XI. 225 (1930).

In describing this species I had overlooked that the genus *Porana* has a fruit very similar to that of the section Synaptea of the genus *Vatica*. The presence of only fruiting specimen caused this error.

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Amorpha brachycarpa E. J. Palmer, sp. nov.
Photograph of the type specimen

CONSPECTUS OF THE GENUS AMORPHA

ERNEST J. PALMER

Plate 36 and text figures

AMORPHA, a genus of leguminous plants of the tribe Psoraleae, is so far as known confined to the temperate and semi-tropical parts of North America, ranging from the Connecticut valley and Saskatchewan to Florida and northern Mexico. One little known species has also been described from further south in Mexico. All of the known species are shrubs of rather uniform habit and characters. About 60 names for species have been proposed of which 20, including one new one, are recognized as valid in the present treatment. There are also several varieties and forms, some of which have previously been described as species by other authors, and a few that are here described for the first time.

Amorpha is rather closely related to the cosmopolitan genus *Psoralea* and to the genera *Dalea* (*Parosela*) and *Eysenhardtia*, the second of which ranges over most of western North America and the last is represented by a few species in the arid southwestern states and in Mexico and Central America.

The genus *Amorpha* was established by Linnaeus in 1753, Species Plantarum II. 743, based upon a plate published in Hortus Cliffortianus in 1737, showing a flowering branch of *Amorpha fruticosa* which thus becomes the type species of the genus. In 1788 a second species *A. herbacea*, was described by Walter, and in 1804 Desfontaines published the name *Amorpha glabra*, which was briefly described three years later by Persoon. Willdenow and Michaux, in 1796 and 1803, added two more names, which proved to be synonyms of Walter's species. The names of several other species were added to the list by Nuttall, Pursh, and Rafinesque from 1813 to 1817, one of which, by the last named author, is unrecognizable. In the meantime Schkuhr had in 1796 published the names *Amorpha perforata* and *A. nonperforata*, which have generally been regarded as applying to mere forms of *A. fruticosa*, and treated as synonyms. When Torrey and Gray issued the first volume of the Flora of North America in 1838 they recognized eight species, descriptions of three of which were published for the first time. Dr. Gray does not seem, however, to have made much progress in understanding the genus, for in 1845 he wrote in Plantae Lindheimerianae: "I know of no constant characters for distinguishing *A. glabra, Desf.*, A. Caroliniana, *Croome*, A. nana, *Nutt.*, *Bot. Mag.*, and A. laevigata,

Nutt. from A. fruticosa. The A. Roemeriana, *Scheele in Linnaea*, 21, p. 461, is doubtless a form of A. fruticosa or of A. paniculata."

The principal recent treatments of the genus are by C. Schneider, Illustriertes Handbuch der Laubholzkunde, vol. II. 68–74 (1907), and by Dr. P. A. Rydberg in the North American Flora, vol. XXIV, pt. 1, pp. 26–34 (1919). Schneider's Handbook contains helpful figures bringing out the distinctions in leaf, flower, and fruit characters of several species; and the key, descriptions and synonomy given in the North American Flora are quite full. Four new species were described by Rydberg, three of which are retained as species in this paper, although the material that I have seen of them is not very full. The fact that the plan of the North American Flora does not admit of the description of varieties has led, as it seems to me, to the acceptance there of some species that cannot always be clearly distinguished and are better treated as forms or varieties, which is the plan followed here.

The principal morphological characters in *Amorpha* on which species can be distinguished are the shape and size of the fruit, the form of the calyx-lobes, and the pubescence. A few species show well marked distinctions in the texture and veining of the leaves, the number and length of the flowering racemes, and in the presence or absence of glands on the calyx and petiolules. In other species, however, these characters are variable.

Amorpha fruticosa and several closely allied forms constitute a group in which it is extremely difficult to find constant characters, and consequently there has been considerable difference of opinion amongst authors in the treatment of these species, and many names have been proposed that must be regarded as synonyms, forms or varieties. *Amorpha tennesseensis* Shuttlew. and *A. fragrans* Sweet are considered varieties of *A. fruticosa* in the present treatment, while *A. occidentalis* Abrams and *A. croceolanata* Wats., for reasons stated in connection with the descriptions, are retained as species. It has also seemed best on the strength of the specimens examined to regard *A. hispidula* Greene as a variety of *A. californica* and *A. arizonica* Rydberg as a variety of *A. occidentalis*.

One of the difficulties in describing species in this genus and especially in constructing a key is the fact that many of the species have both a pubescent and a glabrous form or similar slight differences in a single character. For this reason it has been found necessary to include the varieties in the key and in a few instances to have the same variety or species appear twice.

Most of the species of *Amorpha* occur in the Southern States, and particularly in the coastal plain and piedmont regions. *Amorpha*

fruticosa with its varieties and forms, is the most widely distributed, ranging over most of the United States east of the Rocky Mountains, from Canada to Florida and beyond the Rio Grande into northern Mexico. *Amorpha canescens* is another species of wide range, occurring from Michigan and Indiana and southward through the Mississippi valley and the Great Plains to New Mexico and northern Texas. Most of the other species are much more local. An interesting and surprising fact is the reappearance or the continuance of the range of several of the species originally discovered and most common in the southern Appalachian region in the southwestern part of the Ozark region of central and western Arkansas and eastern Oklahoma. One species, *Amorpha nana*, is found only in the Western plains region, and two or three well marked endemic species are found in Texas.

The significance of the present distribution of *Amorpha* would seem to be that the genus was established at a rather early period, perhaps as early as the middle or late Tertiary, and that it then gave rise to several distinct species which became widely distributed before the uplifting of the western mountains and the incursion of the northern ice sheet isolated them in different regions, where under changed conditions they gave rise to the number of more or less closely related forms of these primitive species which are now found. Outstanding and probably early developed species are *Amorpha nana*, *A. canescens*, *A. herbacea*, *A. paniculata*, *A. glabra*, *A. fruticosa* and *A. texana*. Some of the other species are also well marked but can in most cases at least be accounted for as probably being offshoots of one of the above. My interest in the genus and the present treatment arose from the study and collection of most of the forms in the field for a number of years, the problems suggested by their somewhat puzzling geographic distribution, and the fact that it was often difficult to decide to which species some of the specimens should be referred and to find clear and constant characters separating them.

In addition to the material in the herbarium of the Arnold Arboretum, I have had for study all of the specimens of the Gray Herbarium, the Philadelphia Academy of Natural Sciences, and a number, representing obscure or recently described species, from the New York Botanical Garden collections. I wish to express my thanks to the authorities of all of these institutions for their courtesies. I am also under obligations to my colleagues, Mr. Alfred Rehder, Curator of this herbarium, for aid and suggestions, Dr. C. E. Kobuski, Assistant Curator, for his careful drawings of the fruits and leaflets. In the enumeration of specimens examined the

herbarium in which the specimens are found is indicated by the following parenthetical letters: (A) Arnold Arboretum, (G) Gray Herbarium, (P) herbarium of the Philadelphia Academy of Natural Sciences, (N) herbarium of the New York Botanical Garden.

KEY TO THE SPECIES

Branches, petioles, and rachises of leaves beset with spine-like glands.
  Plants distinctly pubescent; calyx-lobes about as long as the tube.
    1. *A. californica*
  Plants nearly glabrous; calyx-lobes shorter than the tube.
    1-b. *A. californica* var. *hispidula*
Branches, petioles, and rachises of leaves without spine-like glands.
  Low shrubs, usually less than 1 m. high (rarely higher); leaves nearly sessile, the petioles usually shorter than the width of lowest leaflets.
    Plants pubescent or canescent.
      Plants densely canescent throughout.
        Calyx-lobes as long as the tube, all of nearly equal length.
          2. *A. canescens*
        Calyx-lobes about half as long as the tube, the upper two shorter than the lower three.....3. *A. herbacea*
      Plants villous or thinly pubescent or becoming glabrous in age.
        Calyx-lobes as long as the tube; leaflets not conspicuously punctate.
          2-a. *A. canescens* var. *glabrescens*
        Calyx-lobes much shorter than the tube; leaflets conspicuously punctate.....5. *A. floridana*
    Plants glabrous or essentially so at all times.
      Leaflets conspicuously punctate, thick or firm and with revolute margins at maturity.
        Leaflets 15–25, oblong, less than twice as long as wide; flowering racemes usually single or few.....4. *A. cyanostachya*
        Leaflets 21–41, narrow-oblong, about twice as long as wide; flowering racemes clustered, usually several.
          5. *A. floridana* (mature state)
      Leaflets not conspicuously punctate, thin and without revolute margins at maturity.
        Calyx-lobes as long as the tube; flowering racemes several, paniculate.....6. *A. brachycarpa*
        Calyx-lobes about half as long as the tube; flowering racemes usually single, short.....7. *A. nana*
  Tall shrubs, usually 1–3 m. high; leaves distinctly petioled, petioles longer than width of lowest leaflets.
    Branches and foliage glabrous or essentially so.
      Leaflets few (7–17) remote or at least not crowded.
        Calyx-lobes all very short or nearly obsolete.....8. *A. glabra*
        Calyx-lobes longer, at least some of them acute.
          Leaflets broad-oblong, often as broad as long, rounded at both ends or emarginate; calyx glandular, pubescent.
            15-a. *A. texana* var. *glabrescens*
          Leaflets narrower, oblong, ovate or obovate, rarely emarginate; calyx glabrous except ciliate margins of lobes.
            Calyx and petiolules conspicuously glandular; flowering racemes usually elongated (1–2.5 dm. long)..9. *A. laevigata*
            Calyx and petiolules not conspicuously glandular; flowering racemes shorter (0.5–1.5 dm. long).
              Young leaflets sparingly short pilose, slightly paler on lower than on upper surface; bark gray.....10. *A. nitens*

Young leaflets essentially glabrous, glaucous or conspicuously paler on lower than on upper surface; bark very pale. 10-a. *A. nitens* var. *leucodermis*

Leaflets more numerous (15–35), remote or crowded.

Mature leaflets firm or subcoriaceous, margins revolute and usually crenulate; flowers white or pale blue.....11. *A. crenulata*

Mature leaves thin, without revolute margins; flowers purple or indigo.

Flowering racemes usually sessile or closely flowered to the base; pod straight or nearly so.....12. *A. Curtissii*

Flowering racemes usually pedicelled; pod curved.

Leaflets obtuse or emarginate at apex; flowering racemes usually solitary.....20-a. *A. occidentalis* var. *emarginata*

Leaflets rounded or acute at apex; flowering racemes usually several.

Leaflets 11-25, narrowed at base, 1.5–2.5 cm. long. 21-a. *A. fruticosa* var. *angustifolia* f. *glabrata*

Leaflets 19-39, obtuse or rounded at base, 2.5–4 cm. long. 21-c. *A. fruticosa* var. *oblongifolia*

Branches and foliage noticeably pubescent (branches glabrous in *A. nitens*), at least on young growth.

Calyx-lobes from half to fully as long as the tube, all acute or acuminate.

Calyx-lobes fully as long as tube; flowering racemes usually single, 0.5–1 dm. long.....13. *A. Schwerini*

Calyx-lobes about half as long as the tube; flowering racemes usually several, 3–5 dm. long.....14. *A. paniculata*

Calyx-lobes much shorter than the tube, the two upper obtuse or rounded; flowering racemes 1–2.5 dm. long.

Leaflets 7–15, broad-oblong, often as broad as long, usually emarginate; petiolules conspicuously glandular.....15. *A. texana*

Leaflets 11–35, obovate or oblong, 1.5–2 times as long as broad.

Leaflets oblong or ovate, firm and with revolute margins at maturity; petiolules somewhat glandular....16. *A. virgata*

Leaflets mainly oblong or elliptic, varying to ovate or obovate, thin at maturity and rarely with revolute margins; petiolules glabrous or pubescent but not glandular.

Branches, foliage and calyx copiously pubescent.

Pubescence gray; leaflets obovate or oblong, 1.5–2.5 cm. long; flowering racemes usually single. 20-b. *A. occidentalis* var. *arizonica*

Pubescence tawny or rufous; leaflets oblong or ovate, 2.5–6 cm. long; flowering racemes usually several. 17. *A. croceolanata*

Branches and foliage pilose or sparingly pubescent; calyx slightly pubescent or glabrate.

Pubescence sparse, loosely attached; calyx glabrous or nearly so except ciliate margins; pod not conspicuously glandular-dotted.

Mature leaves glabrous and shining above; pod curved (plants turning black in drying).....10. *A. nitens*

Mature leaves dull above; pod straight or nearly so; calyx-lobes almost obsolete (plants not turning black in drying).....18. *A. Bushii*

Pubescence firmly attached, spreading or appressed; pods conspicuously glandular-dotted.

Flowering racemes usually single, 1–2.5 dm. long, sometimes with a second shorter one at base. 19. *A. occidentalis*

Flowering racemes usually several, seldom over one dm. long.
Leaflets mostly ovate or oblong, obtuse or rounded at base; pubescence spreading, usually copious, at least on young growth.
Leaflets 13–25, averaging 1.5–2 times as long as broad, not crowded on rachis.
Leaflets ovate or oblong, rounded or acute at apex, averaging about twice as long as broad.
20. *A. fruticosa*
Leaflets broad-oblong, rounded or emarginate at apex, averaging 1.5 times as long as broad.
20-b. *A. fruticosa* var. *emarginata*
Leaflets 21–35 (rarely more) narrow-oblong or lance-oblong, averaging 2–3 times as long as broad, often crowded on rachis.
Leaflets usually 1–2 cm. long, noticeably pubescent at least on young growth; pod straight or nearly straight.
20-d. *A. fruticosa* var. *tennesseensis*.
Leaflets 2–5 cm. long; pubescence sparse (or glabrate at maturity); pod slightly curved.
20-c. *A. fruticosa* var. *oblongifolia*
Leaflets usually elliptic or obovate, narrowed at base; pubescence short, appressed.
20-a. *A. fruticosa* var. *angustifolia*

1. **Amorpha californica** Nuttall in Torrey & Gray, Fl. N. Am. 1. 306 (1838).—Fig. 1.

A shrub 1–3 m. high; foliage and branches more or less pilose and beset with scattered spine-like glands. Leaflets 11–25, ovate or oblong, 1–3 cm. long, 0.8–2 cm. wide, usually rounded or subcordate at base, obtuse or slightly emarginate and mucronate at apex, thin but firm at maturity, and then scabrate or nearly glabrous above, pilose and conspicuously punctate-dotted beneath; petioles about as long as the breadth of the lowest pair of leaflets. Racemes single or few, erect, 1–2 dm. long, rather loosely flowered; calyx 5–6 mm. long, densely pubescent, the lobes lanceolate, about as long as the tube or a little shorter; standard purple. Pod 6–8 mm. long, curved on back, pubescent and conspicuously glandular-dotted.

Southern California and western Arizona.—Type locality: Santa Barbara, California.

California: Banning Cañon, Riverside County, *A. R. Seitz*, July 16, 1915 (A); between Pozo and La Panza, San Luis Obispo County, *Alice Eastwood*, June 15, 1902 (A); road from San Luis Obispo to Pozo, *Alice Eastwood*, no. 15147, May 17, 1928 (A); Mt. Wilson, Los Angeles County, *Alice Eastwood*, no. 9046, June 20, 1919 (A); Mt. Wilson, *Alfred Rehder*, no. 199, Aug. 1, 1914 (A); Little Santa Anita Cañon, Los Angeles County, *LeRoy Abrams*, no. 2622, July 1, 1902 (A, P); Pitt to Baird, Shasta County, *Alice East-*

wood, no. 1449, July 25, 1912 (A); hills west of Pomona, *I. M. Johnston*, no. 1348, June 14, 1917 (A); San Bernardino Mts., *G. Engelmann & C. S. Sargent*, Sept. 21, 1880 (A); San Bernardino Mts., *S. B. Parish*, nos. 10903, 10958, June 16, June 22, 1916 (A); Monterey County, *T. S. Brandegee*, 1885 (A); Jolono, *C. S. Sargent*, Sept. 12, 1896 (A); Red Reef Cañon, Ventura County, *Leroy Abrams & E. A. McGregor*, no. 130, June 8, 1908 (A); Santiago Peak trail, Orange County, *LeRoy Abrams*, no. 1828, June, 1901 (A); Montgomery Creek, Shasta County, *Alice Eastwood*, no. 632, June 27, 1912 (A); Mt. Wilson, *J. F. McBride & E. Payson*, no. 896, July 25, 1915 (G); Griffins, Mt. Alamo, Ventura County, *A. D. E. Elmer*, no. 3950, July, 1902 (G); Anisal Creek, Santa Cruz Mts., *L. R. Abrams*, no. 3037, July 19, 1913 (G); San Bernadino, *S. B. Parish*, no. 4185, June 26, 1896 (G); Heroult, Shasta County, *L. E. Smith*, no. 402, June 25, 1913 (A, G); San Bernardino Mts., *Philip A. Munz & I. M. Johnston*, no. 8559, July 14, 1924 (G); 4 mls. s. of Oak Glen, San Bernardino County, *Philip A. Munz & I. M. Johnston*, no. 8699, July 17, 1924 (G); Mupa Cañon, near Ojai, *C. E. Peckham*, 1866 (G); *D. Douglas* (without locality or date) (G); Elysian Park, Los Angeles, *E. Brouton*, no. 424, June 1, 1902 (G); Los Angeles, *J. C. Nevin*, 1880 (G); Mt. Wilson, *Geo. B. Grant*, no. 39, May 19, 1904 (G, P); Suey Creek, near Santa Maria, *Alice Eastwood*, no. 400, June 13, July 3, 1906 (A, G); Pit River Ferry, Shasta County, *H. E. Brown*, no. 232½, May 5–28, 1897 (P); San Bernardino, *R. J. Smith*, July 1, 1904 (P).

ARIZONA: Prescott, *Susan D. McKelvey*, nos. 396, 1222, Nov. 8, 1928, June 2, 1929 (A); Copper basin, *J. W. Toomey*, no. 529, June 25, 1892 (A).

1a. **Amorpha californica** var. **napensis** Jepson, Man. Fl. Pl. Calif., 556 (1925).

California.—Type locality: Howell Mt., Napa Range.

I have not seen specimens of this variety. Jepson's description is as follows: Subglabrous; sessile; glands on rachis none; racemes 1–1½ in. long; calyx nearly glabrous and glandless, its teeth minute.

1b. **Amorpha californica** var. **hispidula** (Greene), comb. nov.
Amorpha hispidula Greene, Fl. Francisc. 14 (1891).

Differs from the type in being nearly or quite glabrous throughout, and in the somewhat shorter calyx lobes.

Central and southern California.—Type locality: Monterey County.

CALIFORNIA: Laguinetas, Marin County, *Alice Eastwood*, May, 1895 (G); hills near Pipe Valley, *Berlandier*, no. 2548, in 1863 (G);

Calistoga, *Alice Eastwood*, no. 11743, May 9, 1923 (A); between Cazadero and Sea View, Sonoma County, *Rimo Bacigalupi*, no. 1799, Sept. 3, 1927 (A); Cazadero, *T. S. Brandegee*, July 1, 1923 (A); Nunn's Cañon, Sonoma County, *Michener & Bioletti*, no. 1724/2, May, 1893 (P); near Burke's Sanatarium, Sonoma County, *A. A. Heller*, no. 5757, June 24, 1902 (G, P); Moore Creek, Howell Mt., *W. L. Jepson*, no. 6834, Aug. 6, 1916 (A); Marin Co., *H. N. Bolander*, May, 1873 (G).

2. **Amorpha canescens** Pursh, Fl. Am. Sept. 467 (1814).—Fig. 2.

Amorpha canescens Nuttall, Fraser Cat. (1813), nomen nudum; reprinted in Pittonia, II. 116 (1890).

Amorpha canescens var. a. *typica* C. Schneider, Ill. Handb. Laubholzk. II. 70 (1907).

A low shrub 3–10 dm. high, more or less densely gray-canescent throughout. Leaves nearly sessile; petioles usually shorter than the width of the lowest pair of leaflets; leaflets 15–45 or rarely more, crowded or overlapping, elliptic, oblong or ovate, usually rounded at base, rounded or obtusely pointed at the mucronate apex, 7–20 mm. long, 4–10 mm. wide. Inflorescence terminal, usually with numerous, slender, 8–25 cm. long racemes; calyx villous-canescent, its lobes lanceolate and all of nearly equal length, about as long as tube; standard blue-purple. Pod densely villous-canescent, glandular-dotted, 4–5 mm. long, nearly straight dorsally, with long, ascending beak.

Indiana and Michigan to Manitoba and Saskatchewan and south through the Mississippi valley and plains to Arkansas, New Mexico and northwest Texas.—Type locality: Banks of the Missouri River.

MANITOBA: Killarney, *W. Scott*, Sept. 1892 (G).

SASKATCHEWAN: Winnepeg valley, *E. Bourgeau*, 1857–8–9 (G).

MICHIGAN: Mottville, *Geo. L. Fisher*, no. 27, June 30, 1923 (A, G).

WISCONSIN: St. Croix Falls, *C. F. Baker*, July 8, 1900 (G); Madison, *J. R. Churchill*, Aug. 22, 1893 (G); Kilburn, *C. H. Morss*, July 8, 1884 (G); Prairieville, *I. A. Lapham*, Aug. 14 (G); Lake Wingra (near Madison), *Gilbreth, Jack & Seymour*, Aug. 23, 1893 (A); Wild Rose, *W. L. McAtee*, no. 3050, Aug. 8, 1919 (A); Mauston, Juneau County, *E. J. Palmer*, no. 28429, Sept. 8, 1925 (A); Kilburn, Sauk County, *E. J. Palmer*, no. 27675, June 7, 1925 (A); Falls of St. Croix, *Houghton* (G); Veroqua, Vernon County, *Huron H. Smith*, no. 7239, July 12, 1922 (A); Prairie du Chien, *Huron H. Smith*, no. 7577, July 24, 1922 (A); Sugar Loaf, Columbia County, *Huron H. Smith*, no. 8065, Aug. 5, 1922 (A); Black River Falls, Jackson County, *Huron H. Smith*, no. 6809, June 27, 1922 (A); Milwaukee, *I. A. Lapham* (P).

MINNESOTA: St. Anthony Falls, *J. H. Schuette*, July 14, 1888 (G); Courtland, Nicolette County, *C. A. Ballard*, July, 1892 (G); Bald Eagle, Ramley County, *S. F. Blake*, no. 170, July 4, 1910 (A); Cass Lake, *L. H. Pammel*, no. 50, July 24–26, 1925 (A); Lake Pepin, 75 mls. below St. Paul, ex Herbarium Jno. R. and Jas. Rhodes, no. 875, July 11, 1862 (P).

INDIANA: Miller's, *J. M. Greenman*, Aug. 20, 1908 (G); Howe, LaGrange County, *C. C. Deam*, nos. 14949, 20670, Aug. 29, 1914, July 9, 1916 (A); Ciecott, Cass County, *C. C. Deam*, no. 17843, July 22, 1915 (A); Lakeville, Newton County, *C. C. Deam*, no. 18105, Aug. 24, 1915 (A).

ILLINOIS: Port Byron, *E. T. & S. A. Harper*, June, 1898 (A); Lisle, *A. J. Prisc*, no. 131, Aug. 4, 1925 (A); Utica, *Mrs. Joseph Clemens*, Aug. 7, 1900 (A); East Dubuque, Jo. Daviess County, *E. J. Palmer*, nos. 27877, 27878, June 12, 1925 (A); Oquawka, *Harry N. Patterson*, May–June (G); Macon, Forsythe County, *Allan Gleason*, no. 211, June 10, 1896 (G); Winnebago County, *M. S. Bebb*, 1867 (G, P); Augusta, *S. B. Mead*, July, 1846 (G); Champaigne, *A. S. Peace*, no. 12804, Sept. 11, 1909 (G); Peoria, *F. E. McDonald*, July, 1904 (G); Stony Island, Cook County, *Huron H. Smith*, no. 5961, June 30, 1914 (G); Normal, *B. L. Robinson*, July, 1887 (G); Illinois, *Buckley* (without locality or date) (G); Rockford, Winnebago County, *M. E. Holmes*, 1874 (P); Chicago, *S. C. Williamson*, 1893 (P); Rock Island, *Dr. Sargent*, Oct., 1859 (P); Peoria, *A. J. Stewart* (P); Chicago, *H. W. Clark*, no. 977, July 12, 1902 (P); Delavan, *J. J. Carter*, July, 1879 (P); Beardstown, *Chas. A. Geyer*, July, 1842 (P); between Galena and Chicago, *Mrs. Blandine* (P); Prairies of Illinois, *Lapham*, Sept. 1837 (P); Prairies of Illinois, *C. W. Short*, 1860 (P); Augusta, *S. B. Meade*, Aug. 1852, June 25, 1860 (P); Prairies of Illinois, *Jane Bettle* (P); Waukegan, *T. Meehan* (P).

IOWA: Dennison, Jefferson County, *T. A. Allen*, July 26, 1867 (G); Grinnell, *M. E. Jones*, 1876, July 17, 1877 (G, A); Hamberg, *L. H. Pammel & H. Clark*, no. 19, July 4, 1914 (A); Ames, *Robt. Combs*, no. 572, July 2, 1897 (G); Crawford County, *T. A. Allen*, July 14, 1867 (G); Bentonsport, *E. W. Graves*, no. 1697, July, 1920 (A); Charleston, Lucas County, *E. J. Palmer*, no. 35807, May 18, 1929 (A); *S. C. Williams*, July, 1893 (P).

MISSOURI: *O. E. Lansing, Jr.*, nos. 3109, 3177, June 5–12, 1911 (G); Allenton, *G. W. Letterman*, May 25, 1887 (G); Dumas, *B. F. Bush*, nos. 5890, 9546, 10131, July 7, 1909, Aug. 29, 1921, July 27, 1923 (A); Dumas, *E. J. Palmer*, no. 21879, Sept. 7, 1922 (A); Jerome, *J. H. Kellogg*, no. 366, June 18, 1913 (A); Odessa, *B. F.*

Bush, nos. 11361, 11362, 11363, July 7, 1927 (A); Monteer, *B. F. Bush*, no. 11429, Aug. 4, 1927 (A); Carthage, *B. F. Bush*, no. 10393, Oct. 6, 1925 (A); Knox City, Knox County, *E. J. Palmer*, no. 35922, May 21, 1929 (A); Cole Camp, Benton County, *E. J. Palmer*, nos. 26363 (in part), 30083, Oct. 1, 1924, May 12, 1926 (A); Howe's Mill, Dent County, *E. J. Palmer*, no. 34937, July 3, 1928 (A); Watson, Atchison County, *E. J. Palmer*, no. 18937, Sept. 3, 1920 (A); Maryville, Nodaway County, *E. J. Palmer*, no. 25439, June 13, 1924 (A); Forest City, Holt County, *E. J. Palmer*, nos. 25395, 26004, June 12, Sept. 2, 1924 (A); Swope Park (Jackson County), *B. F. Bush*, no. 10358, Oct. 10, 1924 (A); Montieth Junction, Bates County, *E. J. Palmer*, no. 26076, Sept. 10, 1924 (A); Webb City, Jasper County, *E. J. Palmer*, June 16, 1901, no. 22319, Oct. 17, 1922 (A); along James River, Stone County, *E. J. Palmer*, no. 5840, June 2, 1914 (A); Mansfield, Wright County, *E. J. Palmer*, no. 34691, June 25, 1928 (A); St. Louis, *Nuttall* (P); Hannibal, *J. Davis*, June 19, 1917 (P); Meramec Highlands (St. Louis County), *E. B. Bartram*, no. 1507, May 27, 1911 (P).

North Dakota: Bismarck, *Esther L. Larsen*, no. 170, Aug. 12, 1929 (G); Fargo, *H. L. Bolly*, no. 120, July, 1892 (G, P); Buckhouse slough, Hankinson, *F. P. Metcalf*, no. 170, July 23, 1917 (A); Dakota (without locality or date) *Dr. Gladfelter* (P).

South Dakota: White Rock, *Mrs. H. O. Powell*, July, 1903 (G); Brookings, *John J. Thurberer*, July 17, 1894 (G); Big Stone, *T. A. Williams*, no. 160, Aug. 14, 1894 (A); Pine Ridge Indian Reservation, Washabaugh County, *E. J. Palmer*, no. 37641, June 29, 1929 (A); Piedmont, Lawrence County, *E. J. Palmer*, no. 37024, June 8, 1929 (A).

Nebraska: Plummer's Ford, Dismal River, Thomas County, *P. A. Rydberg*, no. 1417, July 8, 1893 (G); Kearney, *J. H. Holmes*, 1889 (A); Whitman, *J. M. Bates*, no. 6011, July 22, 1914 (A); Omaha, *C. Williamson*, Aug., 1889 (P).

Kansas: Riley County, *J. B. S. Norton*, nos. 88, 88a, 1895, 1896 (G); Wichita, *S. F. Poole*, May, 1905 (G); Osborne City, *C. L. Shear*, no. 105, June 11, 1894 (G); Neodesha, Wilson County, *E. J. Palmer*, no. 22017, Sept. 19, 1922 (A); Ellsworth, Ellsworth County, *E. J. Palmer*, no. 21269, May 13, 1922 (A); Lyons, Rice County, *E. J. Palmer*, no. 21224, May 10, 1922 (A); Hays, Hays County, *E. J. Palmer*, no. 21310, May 15, 1922 (A).

Oklahoma: Cora, Woods County, *G. W. Stevens*, no. 748, May 28, 1913 (A); Cache, Comanche County, *G. W. Stevens*, no. 1338½, June 25, 1913 (A); Miami, Ottawa County, *G. W. Stevens*, no. 2457, Aug. 27, 1913 (A); Fonts, Lincoln County, *Clara Means*, June 13,

1895 (G); Huntsville, Kingfisher County, *Laura A. Blankenship*, May 30, 1896 (G); Witchita Mts., Marcey Expedition, 1852 (G); Kenton, Cimarron County, *G. W. Stevens*, no. 492, May 15, 1913 (G); Elk City, Beckham County, *E. J. Palmer*, no. 12567, June 16, 1917 (A); Seiling, *D. M. Andrews*, no. 67, Aug. 17, 1915 (A); Sapulpa, *C. B. Williams*, July 2, 1924 (P).

ARKANSAS: *Dr. Pitcher* (without locality or date) (P).

WYOMING: Sundance, Crook County, *Aven Nelson*, no. 5919, July 24, 1910 (G).

NEW MEXICO: Las Vegas, San Miguel County, *Bro. Anect*, no. 136, June 1920 (G); Vermejo Park, *Mrs. O. S. St. John*, no. 184, July–Aug., 1894 (G); La Cueva, Mora County, *Bros. G. Arsène & A. Benedict*, no. 17104, July 2, 1926 (A); Las Vegas Hot Springs, *Alfred Rehder*, no. 643, Sept. 21, 1916 (A).

TEXAS: Gamble's Ranch, Armstrong County, *E. J. Palmer*, no. 13980, June 6, 1918 (A).

Frequently cultivated in American and European Parks and gardens.

2a. **Amorpha canescens** var. **glabrata** Gray, Pl. Wright. I. 49 (1852).

Amorpha canescens β. *leptostachya* Engelmann apud Gray, Mem. Am. Acad. Sci. II. 4, 31 (1849), nomen nudum.

Differs from the typical form in the branches and foliage being only sparsely pubescent or glabrate and in the greener color of the leaves. The amount of pubescence is extremely variable and a complete series of gradations may be found between this variety and the typical form. In depauperate specimens the leaflets are often very small and the inflorescence is reduced to a single short spike. These variants perhaps deserve only to be regarded as forms, but to avoid making a new combination I am retaining Dr. Gray's varietal name.

Illinois and Missouri to Texas and New Mexico.—Type locality: eastern Texas.

MISSOURI: Medill, Clark County, *B. F. Bush*, no. 9162, Aug. 23, 1920 (A); Forest Mill, Jasper County, *E. J. Palmer*, no. 21673, June 2, 1922 (A); Neck City, Jasper County, *E. J. Palmer*, no. 20523, Sept. 19, 1921 (A); Melugin, Jasper County, *E. J. Palmer*, no. 25305, June 4, 1924 (A); Galena, Stone County, *E. J. Palmer*, no. 26150, Sept. 16, 1924 (A); Pontiac, Ozark County, *E. J. Palmer*, no. 33126, Oct. 12, 1927 (A); Columbia, cliffs of Grindstone, *Francis P. Daniels*, July, 1903 (University of Missouri Herbarium); Cole Camp, Benton County, *E. J. Palmer*, no. 26362, Oct. 1, 1924 (in part) (A).

OKLAHOMA: Kenton, Cimarron County, *G. W. Stevens*, no. 492, May 15, 1913 (in part) (G).[1]

TEXAS (?): *F. Lindheimer*, no. 37, 1843 (G).[2]

Sometimes cultivated in America and Europe.

3. **Amorpha herbacea** Walter, Fl. Car. 179 (1788).—Fig. 3.

Amorpha pubescens Willdenow, Berlin. Baumz. 17 (1796).

Amorpha pumila Michaux, Fl. Bor. Am. II. 64 (1803).

Amorpha herbacea var. a. *typica* C. Schneider, Ill. Handb. Laubholzk. II. 67 (1907).

Amorpha herbacea var. b. *Boyntoni* C. Schneider, l. c.

A low suffruticose shrub, usually less than one m. high, finely canescent throughout. Leaves very short-petioled; leaflets 11–41, elliptic, oblong, or slightly oval, 1–2 cm. long, 0.6–1 cm. wide, rounded at both ends or abruptly pointed at the apiculate apex, with the veins, except the mid-rib, inconspicuous. Inflorescence of numerous slender, rather loosely flowered racemes, 1–3 dm. long; calyx villous, the two upper lobes broadly triangular and shorter than the lanceolate, acuminate lower ones, which are fully half as long as the tube; standard white or pale violet. Pod nearly straight dorsally, 4–5 mm. long, pubescent, with conspicuous dark glandular dots.

North Carolina to Florida and Georgia.—Type locality: Carolina.

NORTH CAROLINA: Kingston, Lenoir County, *L. F. & Fanny R. Randolph*, no. 560, July 9, 1922 (G); *Curtiss* (without locality or date) (G); Bladen County, ex Biltmore Herbarium, no. 35b, June 20, 1897 (A, G, P); Wilmington, *T. G. Harbison*, no. 3, June 21, 1915 (A); Wilmington, *C. S. Williamson*, July, 1895 (P); Wilmington, *M. A. Curtis* (without date) (P); eastern North Carolina, *Gerald McCarthy*, no. 51, July, 1885 (P); Carolina, *Pinkney* (without locality or date) (P);

SOUTH CAROLINA: Santee Canal, *H. W. Ravenel*, (G); Calhoun Falls, *T. G. Harbison*, no. 9, May 20, 1918 (A); *M. A. Curtis* (without locality or date) (G).

GEORGIA: Rabun County, *T. G. Harbison*, no. 187, Oct. 1, 1910 (A); Augusta, *C. S. Sargent*, April 29, 1914 (A); Pulaski, Bulloch County, *R. M. Harper*, no. 9421, June 24, 1921 (A); Georgia, *Nuttall* (without locality or date) (P); Baldwin?, ex Herbarium

[1] The sheet of this number in the Gray Herbarium seems to belong to this variety, while that of the same number in the Arnold Arboretum Herbarium is of the typical form.

[2] This interesting specimen has the small, green, glabrate leaves of this variety, and the slender loosely flowered racemes are 13–26 cm. long. The sheet is labelled: "Flora Texana exsiccata. 37. A. paniculata Torr. & Gray. Fasc. I, leg. F. Lindheimer, 1843." The sheet also bears the notation: "N. B.—There has evidently been a confusion of labels and plants on this sheet. This is certainly not Lindheimer's 37." The specimens seem to agree best with Engelmann's var. *leptostachya*.

Schweinitz (without date) (P); Milledgeville, *Samuel Boykin* (without date) (P).

FLORIDA: Tampa Bay, *Otto Visterland*, no. 3, May, 1887 (A); Brookville, Hernando County, *E. J. Palmer*, no. 27352, May 18, 1925 (A); Florida, *Leavenworth* (without locality or date) (G); New Market, ex Herbarium A. C. Hexamer and F. W. Maier, June, 1855 (G); Richland, Pasco County, *A. H. Curtiss*, no. 6664, June 15, 1900 (G, P); St. Johns River, between Palatka and St. Augustine, *Rugel*, July, 1848 (G); near Manatee River, *Rugel*, no. 165, June, 1845 (G); Sumpter County, *A. H. Curtiss*, no. 573, June (P); Eustis, Lake County, *Geo. V. Nash*, no. 1976, June 16–30, 1895 (P); Florida, *A. W. Chapman* (without locality or date) (P); John's Pass, *S. M. Tracy*, no. 7794, May 26, 1901 (G).

Sometimes cultivated in American and European gardens.

4. **Amorpha cyanostachya** M. A. Curtis in Boston Jour. Nat. Hist. I. 140 (1835).—Fig. 3.

?Amorpha pumila Schlechtendahl, Ind. Sem. Hort. Hal. 8 (1848).
Amorpha caroliniana Rydberg in N. Am. Fl. XXIV. 29 (1919).—Not *A. caroliniana* Croom.

A shrub 1–2 m. high; branches glabrous or sparingly pilose. Leaves 1–1.5 dm. long; petioles short, 8–12 mm. long; leaflets oblong or elliptic, 15–25 mm. long, 8–12 mm. wide, rounded at both ends or acute at the mucronate apex, glabrous or nearly so, dark green and glossy above, paler and conspicuously punctate-dotted beneath, of firm texture and with revolute margins at maturity. Flowering racemes single or few in cluster, slender, 0.5–1 dm. long; calyx glandular, glabrous, except the ciliate margins of the teeth, the upper two of which are obtuse or broadly triangular and the lower three acute and subulate-pointed; standard bright blue. Pod about 5 mm. long, conspicuously glandular-dotted, straight or nearly so on back.

North Carolina to Florida and Alabama, near the coast.—Type locality: Wilmington, N. C.

NORTH CAROLINA: Wilmington, *T. G. Harbison*, no. 16, June 11, 1917 (A); Wilmington, *Edward A. Bartram*, Oct. 6, 1908 (P); Wilmington, ex Biltmore Herb. no. 1381L, July 1, 1904 (P); Swain County, *H. C. Beardslee & C. A. Kofoid*, July 17, 1891 (P); Hamlet, *C. S. Williamson*, May 20, 1895 (P).

FLORIDA: West Florida, *Chapman*, ex Biltmore Herb., no. 5767, June, 1890 (G); East Florida, *Chapman* (without locality or date) (G); Florida, ex Torrey Herb. (without locality or date) (G).

ALABAMA: Banks of Alabama River, *S. B. Buckley*, Aug. 1840 (G).

By comparing the original descriptions of *A. caroliniana*[1] and of *A. cyanostachya*[2] with that given by Rydberg in N. Am. Fl. it will be seen that Croom's plant cannot have been the glabrous species there referred to it. His insistence on the short solitary spike and characterization of a plant with pubescent branches and leaves covered on both surfaces with minute shining hairs is somewhat suggestive of *A. Schwerini*, which is so distinct that it would have been likely to have attracted the attention of earlier botanists. I hesitate, however, to refer that species to it as a synonym, as the pubescence on Schneider's plant is soft and copious, and I do not know of any specimens from the vicinity of Newbern. In fact I have seen no specimens that in all respects agree with the original description. Curtis describes the leaves of *A. cyanostachya* as glabrous, and in their number and other characters as well as those of the calyx and flowers it agrees with the specimens here referred to it. The author's note comparing it with *A. fruticosa*, from which it is distinguished by its shorter, more pubescent spikes, throws some doubt upon it. However, the plant which he called *A. fruticosa* about Wilmington probably was not that species and may have been *A. glabra*.

Since the description given of *A. caroliniana* appears to be too indefinite to be applied to any plant known in the region, it seems advisable to abandon it, and I am taking up Curtis' name for this plant, which is a common species in the neighborhood of Wilmington, to avoid adding another name, since it agrees with it more fully, although not clear in all particulars.

5. **Amorpha floridana** Rydberg in N. Am. Fl. XXIV. 31 (1919).—Fig. 5.

A shrub 1–1.5 m. high; branches sparingly villous. Leaves 1–1.5 dm. long, petioles short (0.5–1 cm. long), equalling or shorter than the lowest leaflets; leaflets 21–41, narrow-oblong, rounded at both ends, glabrous or nearly so above, paler and conspicuously glandu-

[1] Amorpha * caroliniana.

Plant shrubby, four to five feet high; branches pubescent, striate; leaves pinnate; leaflets oblong, obtuse, mucronate, petiolate, covered on both surfaces with minute, shining hairs, and thickly studded with diaphanous glands; spike *solitary, short;* flowers very small, dark purple, approaching to indigo; calyx sprinkled with minute hairs. Found by Dr. Loomis in 1832, near Newbern, flowering in July.

[2] *Amorpha cyanostachya.* Leaflets oblong, emarginate, obtuse at each end, smooth; Rachis pubescent; Flowers subsessile; Calyx with the margins villous, two of the teeth short, obtuse, and three acuminate, subaristate, nearly equal; Vexillum obcordate, more than twice the length of the calyx.

Obs. Leaflets 10–15 pairs, 6–9 lines long, 3–4 wide, glandular, occupying the petiole nearly to the stem. Flowers blue, darker at the summit of the vexillum, and becoming lighter towards the base. This species is distinguished from *A. fruticosa* by its different colored flowers; shorter pedicels; spikes shorter, more pubescent, and less attenuated; a calyx at base; shorter stamens; and smaller and more numerous leaflets.

lar-dotted beneath, more or less pubescent when young, becoming glabrous at maturity and then firm in texture and with slightly revolute margins. Racemes numerous, clustered, 5–15 cm. long; rachis villous; calyx 3–4 mm. long, slightly puberulent or glabrous, glandular-dotted; calyx-lobes short with ciliate margins, the upper two broadly triangular, obtuse, the lower three lance-triangular; standard purple. Pod 4–5 mm. long, conspicuously glandular-dotted, slightly curved dorsally.

Florida.—Type collected by Chapman (without definite locality).

FLORIDA: *Chapman* (without locality or date) (Type) (N); *Chapman*, west Florida, June, 1890, ex Biltmore Herb., no. 5767 (A, N); *Chapman* (without locality or date), ex Torrey Herb. (N); Apalachicola, *B. F. Saurman*, 1867 (P).

6. **Amorpha brachycarpa**, sp. nov.—Plate 36 and Fig. 6.

Frutex erectus gracilis 6–9 dm. altus, ramis paucis, glabris vel parce pubescentibus. Folia numerosa subsessilia, rachibus gracilibus canaliculatis; foliola densa vel imbricata, 21–45, oblonga, 8–15 mm. longa et 4–8 mm. lata, apice rotunda vel emarginata, mucronata, basi rotundata vel subcordata, matura papyracea, glabra vel parce ciliata, marginibus revolutis, costis nervisque prominentibus, reticulata. Inflorescentia paniculata, 1–2.5 dm. longa, ramis multis gracilibus dense floriferis; pedicelli glabri, 1–1.5 mm. longi; calyx turbinatus, angulatus, glaber vel fere glaber; sepala lanceolata, ciliata, superiores tubo triente breviores, inferiores tubum aequantes vel longiores; vexillum obovatum, apice truncatum vel leviter emarginatum, purpureo-caeruleum; stamina et stylus glaber exserta. Legumen obliquo-obovatum, 4–5 mm. longum, 3–3.5 mm. latum, dorso recto, calycis dentes vix excedens, atrobrunneum, manifeste glanduloso-punctatum, monospermum, rostro incurvo.

A slender shrub 6–9 dm. tall, with few, erect, glabrous or sparsely pubescent, grooved branches. Leaves numerous, 7–12 cm. long, sessile or nearly so, with 21–45 oblong leaflets, rachis slender, glabrous or nearly so, channeled above; stipules inconspicuous, linear-subulate, 1–1.5 mm. long; leaflets approximate, crowded or imbricately overlapping, oblong, symmetrical or slightly oblique, 8–15 mm. long, 4–8 mm. wide, rounded or subcordate at base, rounded or slightly emarginate and mucronate at apex, the terminal one reduced and often nearly orbicular and deeply emarginate, thin but firm, glabrous or with a few ciliate hairs on the margins and on the veins beneath, margins slightly revolute, the mid-vein prominent and the secondary veins rather conspicuous on the slightly reticulate lower surface; petioles glabrous, about 1 mm. long. In-

florescence paniculately branched, 1–2.5 dm. long, of many, erect, slender, closely-flowered branches; flowers on very short (1–1.5 mm.) pedicels; calyx turbinate, 4–5 mm. long, the tube angled, glabrous or nearly so, except the lanceolate, acuminate, calyx-lobes, the upper two of which are about two-thirds the length of the tube and the lower ones fully as long or longer than tube, ciliate on the margins; standard obovate, truncate or slightly emarginate at apex, bright violet-blue; stamens and glabrous style exserted. Fruit obliquely obovate, 4–5 mm. long, 3–3.5 mm. wide, much flattened, nearly straight on the back, terminated by curved beak and persistent style, dark brown, with conspicuous resinous dots, margins slightly thickened, one-seeded, the pod scarcely exceeding the calyx-lobes.

Barrens and glades of the Ozark region, Missouri.—Type locality: Galena, Stone County.

MISSOURI: Galena, Stone County, *E. J. Palmer*, no. 19197 (type), Sept. 27, 1920 (A); nos. 20649, 22853 (paratypes), Oct. 1, 1921, May 24, 1923 (A).—Cultivated specimens: Arnold Arboretum, under numbers 15781, 20002, collected Sept. 19, 1923, Aug. 4, Sept. 23, 1924, Sept. 23, 1929 (paratypes) (A).

This little species of *Amorpha* resembles *A. nana* in size, habit and foliage. However, it is well distinguished from that species by the large, many-branched panicle, and by the relatively short tube and long teeth of the calyx, the latter about equalling the broad pod with its strongly reflexed beak. From *A. canescens*, to which it is perhaps most closely related, it is distinguished both by its glabrous character and by the relatively broader, much flattened, straight-backed pod, with strongly reflexed beak. The leaflets are also relatively shorter and broader than in typical forms of *A. canescens*.

The type locality where *Amorpha brachycarpa* was discovered is typically Ozarkean in topography and flora. It was growing in limestone glades, in openings of deciduous woods, where it was locally abundant. It should be looked for in similar situations at other localities in the Ozarks.

Plants grown at the Arnold Arboretum, both from seeds and roots collected at the type locality, have produced flowers and fruit, retaining all of the distinguishing characters of the parent plants, and since specimens collected from these, especially at flowering time, were in even better condition than the native material, both have been drawn upon for the description and figures.

7. **Amorpha nana** Nuttall in Fraser, Cat. (1813); reprinted in Pittonia, II. 116 (1890).—Fig. 7.

Amorpha microphylla Pursh, Fl. Am. Sept. 466 (1814).
Amorpha punctata Rafinesque, New Fl. III. 14 (1838).

A low, erect shrub 3–9 dm. high, glabrous or nearly so throughout. Leaves numerous, 3–10 cm. long, with very short petioles; leaflets 15–31, oblong, oval, or slightly obovate, rounded or abruptly narrowed at base, rounded or emarginate and mucronate at apex, 8–14 mm. long, 4–8 mm. wide, firm and slightly reticulate, green on both sides. Inflorescence of single or few erect, densely-flowered racemes, 3–8 cm. long; calyx-lobes lanceolate, acuminate, about half as long as the tube; standard purple. Pod about 5 mm. long, straight dorsally, with short, erect, or slightly oblique beak, densely punctate-dotted.

Iowa and Kansas to Saskatchewan and south to New Mexico.—Type locality: near Mandan, North Dakota.

Iowa: Armstrong, *R. I. Crotty*, June–July, 1892 (A, G); Prairies, Emmet County, *R. I. Crotty*, Sept. 26, 1882 (P).

Kansas: Ellis County, *E. N. Plank*, no. 18, 1884 (G).

Minnesota: Blue Earth River, *Dr. Parry*, 1848 (G, P); New Ulm, *Lesquereaux*, June, 1856 (G); Wheaton, Travers County, *E. P. Sheldon*, Sept., 1893 (G); Minnesota, *E. V. Campbell*, 1882 (without locality or date) (G); Upper Mississippi, ex herbarium J. Torrey (without exact locality or date) (G); Stevens Expedition, *Dr. Buckley*, (without locality or date).

North Dakota: Pembia, *E. Coms*, 1873 (G); Upper Missouri, Stevens Expedition, *Dr. Buckley* (without definite locality or date) (G); Northwest Territory, *I. N. Nicolette*, no. 175 (without exact locality or date (P); Missouri (River), *Nuttall* (without definite locality or date, but marked with *, used by Nuttall to indicate new species).

South Dakota: White Rock, *Mrs. H. O. Powell*, June, 1903 (G); bluffs of the Missouri, Ft. Pierre, *T. A. Williams*, Aug. 4, 1891 (A); White River, *E. C. Sterns* (A); Lymon County, opposite Chamberlain, *E. J. Palmer*, no. 36091, June 7, 1929 (A); Creston, Pennington County, *E. J. Palmer*, no. 37239, June 14, 1929 (A).

Manitoba: Winkler, *John Macoun*, no. 12530, Aug. 6, 1896 (G); 6 mls. east of Forest, *John Macoun & William Herriot*, June 19, 1906 (G); Winnepeg Valley, *E. Bourgeau*, 1859 (G).

Saskatchewan: Assiniboine River, *J. Macoun*, no. 103, June 14, 1879 (G).

Cultivated for many years in American and European gardens.

Some doubt as to the identity of Nuttall's plant of Fraser's Catalogue has existed as a result of the note in Torrey & Gray, Flora of North America, I. 690. But the brief description accompanying the name, and the locality given by Nuttall, as well as the fact that Pursh in proposing his later name, *Amorpha microphylla*, cites

Amorpha nana, Fraser, Catal. as a synonym, seems to be sufficient ground for using the name *A. nana* rather than the later one of Pursh. The confusion apparently arose merely from the fact that a form of *Amorpha fruticosa*, obtained under the name *A. nana* from the Fraser nursery was cultivated in England. Nuttall's note in the Fraser catalogue is as follows:

"This is a very elegant dwarf shrub, with highly odorous purple flowers. Collected near the Mandan towns, 1600 miles up the Missourie. It is perfectly glabrous, dentures of the calyx all acuminate, and the legume one seeded. It appears intermediate between *A. fruticosa* and *A. pubescens*, from both of which it is evidently distinct."

8. **Amorpha glabra** Desfontaines, Tabl. École Bot. Paris, 192 (1804), nomen nudum.—Persoon, Syn. Pl. II. 295 (1807), nom. seminudum.—Poiret in Lamarck, Encycl. Méth. Suppl. I. 330 (1810).—Fig. 8.

Amorpha montana Boynton in Biltmore Bot. Studies, I. 138 (1902).

?Amorpha fruticosa var. *glabra* Bean, Trees & Shrubs Brit. Isles, I. 193 (1914).

Stout shrubs, 1–1.5 m. high, glabrous or essentially so throughout. Leaves 1–2 dm. long; petioles 1.5–3 cm. long; leaflets 9–21, oblong, oval or slightly obovate, 1.5–4 cm. long, 1–2.5 cm. wide, rounded at both ends or somewhat emarginate at apex, and rarely narrowed at base, thin, dark green above, paler beneath, with inconspicuous veins. Flowering racemes usually single, 1–2 dm. long, rather loosely flowered, sometimes with one or two shorter ones at base; calyx campanulate, 3–4 mm. long, the lobes very short and broad, or the upper sometimes nearly obsolete; standard bright purple. Pod obliquely ovate in outline, straight dorsally, 7–8 mm. long, with short, erect or slightly deflexed beak, covered with numerous small glandular dots on upper part.

North Carolina and Georgia to Tennessee, and in the Ozark region of southern Arkansas and eastern Oklahoma. Found on rocky mountain slopes of the Piedmont regions.

North Carolina: Chimney Rock, Rutherford County, ex Biltmore Herbarium, no. 14f, May 10, 1898 (G); Asheville, *B. L. Robinson*, no. 47, Aug. 1, 1893 (G); Cedar Cliff, Buncombe County, *T. G. Harbison*, no. 20, Oct. 14, 1905 (A); Highlands, *T. G. Harbison*, no. 24, May 22, 1918 (A); Tuckaslegee River, Jackson County, *T. G. Harbison*, no. 1595, May 19, 1914 (A); Macon County, *T. G. Harbison*, no. 133, Sept. 6, 1914 (A); Weldon, *C. S. Williamson*, July (P); Hot Springs, ex Herb. Charles E. Smith, May, 1889 (P); Hog-back Mountain, *C. S. Sargent*, Sept. 22, 1885 (A); Biltmore, ex

Biltmore Herb., no. 14, May 13, 1896 (A); White Oak Mountain, Polk County, ex Biltmore Herb., no. 14d, May 31, 1897 (A); Swain County, *T. G. Harbison*, no. 1594, May 18, 1914 (A); Swain County, *H. C. Beardslee & C. A. Kofoid*, July 7, 1891 (G, P).

ALABAMA: Huntsville, *C. S. Sargent*, Oct. 9, 1898 (A).

OKLAHOMA: Page, Le Flore County, *E. J. Palmer*, nos. 9038, 20572, 20913, 21645, Oct. 27, 1915, Sept. 23, 1921, April 25, 1922 (A).

CULTIVATED: Arnold Arboretum; Hort. Vilmorin, Verrières, France.

9. **Amorpha laevigata** Nuttall apud Torrey & Gray, Fl. N. Am. I. 306 (1838).—Fig. 9.

Amorpha laevigata var. *typica* C. Schneider, Ill. Handb. Laubholzk. II. 74 (1907).

A glabrous shrub 1–2.5 m. high. Leaves 1–2 dm. long; petioles slender, 2–3 cm. long; leaflets 7–21, oblong or obovate, 2–3 cm. long, 1–2 cm. wide, rounded at both ends or cuneate at base and sometimes slightly emarginate at apex, thin, conspicuously punctate beneath; petiolules conspicuously glandular. Flowering racemes usually 2 or 3 (sometimes more), slender, 1.5–3 dm. long; calyx glabrous, glandular-dotted; calyx-lobes short, the upper two rounded, the lower three lanceolate, acute; standard indigo or purple. Pod about 5 mm. long, conspicuously glandular dotted, nearly straight dorsally.

Oklahoma to Texas.—Type locality: Banks of Arkansas River near Salt River (Oklahoma).

TEXAS: Houston, Elihu Hall, no. 128, June 10, 1872 (G, N); *Lindheimer* (without locality or date) (P); *Lindheimer*, no. 38, April 1842 (G, P).[1]

I have been in some doubt as to the wisdom of maintaining the name, *A. laevigata*, Nutt., since there seems to be considerable uncertainty as to just what the plant is that was collected by Nuttall on the banks of the Arkansas River, in what is now Oklahoma. The description given in Torrey and Gray's Flora, based on his notes, seems to indicate a very distinct plant and I do not know of any from the region that quite agrees with it in all particulars. Torrey and Gray state that they had seen no specimen of it and I have been unable to find any so named by Nuttall. Since its publication the name has been applied to various glabrous or nearly glabrous

[1] A specimen in the Gray Herbarium, J. Reverchon, no. 814, on the label of which has been written in another hand: "Collected by Ball on the Neches, Van Zant County, July, 1877," and another branch on the sheet, which looks like the same collection, labelled: "Reverchon, N. W. Texas," have small, cuneate leaves, truncate to deeply emarginate at apex. It is a very curious form of *A. laevigata*, but without better material or more definite data I hesitate to describe it as a distinct variety.

forms of *Amorpha* by collectors, and the expanded descriptions of later authors seem to be based on a composite description of these.

In 1862 Buckley described *Amorpha texana* from west-central Texas, giving a clear and definite description of his type specimen, which is now preserved in the herbarium of the Philadelphia Academy of Natural Sciences. The form described by Buckley differs widely from the description of *A. laevigata*, being a plant with pubescent branches, short, few-spiked inflorescence, and broad-oblong leaflets, pubescent on under surface, rounded or emarginate at the apex and not at all narrowed at base. However, *A. texana* proved to be quite a variable species, and there is a form with leaflets glabrous or nearly so, although with pubescent calyx, which Dr. Gray identified with Nuttall's species, making it a synonym and calling the pubescent (typical) form var. *pubescens*. Specimens have also been collected in Texas which agree with *A. texana* in having the conspicuously punctate leaves and glandular calyx and petiolules which characterize the entire group, but in which the flowers are smaller, the calyx is essentially glabrous, the flowering racemes slender and elongated and the leaves sometimes narrowed at the base. This agrees fairly well with the description of *A. laevigata* as given by Torrey and Gray,[1] and it seems best to distinguish it by the older name, and to maintain Buckley's name for the commoner Texan plant, since the extreme forms differ so widely and scarcely can be brought under one specific description, although probably closely allied genetically and perhaps passing into each other.

10. **Amorpha nitens** Boynton in Biltmore Bot. Studies, I. 139 (1902).—Fig. 10.

A shrub 1–3 m. high; branches glabrous, angled. Leaves 1–2.5 dm. long, ascending; petioles 1–3 cm. long; leaflets 9–19, oblong or oblong-ovate, rounded at both ends or rarely abruptly pointed or slightly emarginate at apex, 2–6 cm. long, 1–2 cm. broad, thin, glabrous and at maturity shining above, usually thinly pubescent on the under surface, inconspicuously feather-veined (often turning black in drying). Racemes usually solitary, 0.5–2.5 dm. long, rarely with one or more additional short ones at base; rachis glabrous or

[1] *Amorpha laevigata* (Nutt. mss.): "glabrous and very smooth; leaves large; leaflets distant, elliptical oblong, attenuate below: the common petiole short; stipules minute; bracts rather long and subulate, caducous; calyx very glandular; the teeth acute, the three lower ones longer and accuminate; vexillum deep blue, about the length of the calyx; legume 1-seeded.

"Banks of the Arkansas, near Salt River,—A very distinct large shrubby remarkably smooth species, with large, distant and very obtuse leaflets, and long (8–10 inches) clustered terminal spikes. Calyx nearly glabrous except the margin, covered with elevated glands." *Nuttall.*—This species we have not seen. It is apparently allied to A. paniculata.

nearly so; calyx narrowly conic, about 3 mm. long, striate, glabrous except the ciliate margins of the lobes; calyx-lobes much shorter than the tube, the two upper ones very obtuse or rounded, the lower ones ovate, acute; standard blue-purple. Pod about 7 mm. long, curved, nearly glandless.

Georgia and Alabama to southern Illinois and in the Ozark region of Western Arkansas.—Type locality: Waynesboro, Georgia.

GEORGIA: Augusta, *T. G. Harbison*, nos. 1531, 1536, May 5, 1914 (A); Milledgeville, *Samuel Boykin* (P).

ALABAMA: Valleyhead, *T. G. Harbison*, no. 533, May 2 (A).

ILLINOIS: Golconda, Pope County, *E. J. Palmer*, nos. 15371, 23778, June 5, 1919, Sept. 17, 1923 (A).

ARKANSAS: Little Rock, Pulaski County, *E. J. Palmer*, no. 22967, May 31, 1923 (A); Gulpha, Garland County, *E. J. Palmer*, no. 24555, April 25, 1924 (A); Magnet Cove, Hot Springs County, *E. J. Palmer*, nos. 26915, 29724, April 24, 1925, April 19, 1926 (A); Hot Springs, Garland County, *E. J. Palmer*, nos. 23027, 23148, 24485, 24888, 24908, 26862, June 3, 7, 1923, April 22, May 14, 1924, April 22, 1925 (A); Wynne, Cross County, *E. J. Palmer*, no. 31662, Sept. 9, 1926 (A).

10-a. **Amorpha nitens** var. **leucodermis**, var. nov.
Amorpha leucodermis Boynton in Herb.

A typo recedit foliolis subtus pallidis vel leviter glaucescentibus et cortice pallidiore.

GEORGIA: Augusta, *F. E. Boynton*, nos. 666, 7035 (type), April 30, Sept. 3, 1902 (G).

11. **Amorpha crenulata** Rydberg in N. Am. Fl. XXIV. 30 (1919).—Fig. 11.

A shrub 1–1.5 m. high, nearly glabrous throughout. Leaves 1–2.5 dm. long, with rather remote leaflets and short (1–1.5 cm.) petioles; leaflets relatively narrow, oblong, linear-oblong or sometimes narrowly ovate or obovate in outline, 1.5–4 cm. long and 0.5–1.2 cm. wide, acute or rounded at base, obtusely pointed, truncate or slightly emarginate at apex, margins often obscurely crenulate, bright green above, paler and finely punctate-dotted beneath, firm and slightly reticulate at maturity; petiolules more or less glandular. Flowering racemes slender, one to several, rather loosely flowered below; calyx 3–4 mm. long, usually glandular, glabrous except the short ciliolate margins of the acute lobes, the lower three of which are lanceolate and about half as long as the tube; standard white. Pod 6–7 mm. long, nearly straight on the back, conspicuously glandular-dotted above the middle.

Southern Florida.—Type locality: hammocks between Cocoanut Grove and Cutler.

FLORIDA: Fort Dallas, *Dr. Cooper* (G); Miami Road, Cocoanut Grove, *Miss O. Rodham*, 1910 (A, P); near Little River, *Alfred Rehder*, no. 738, April 25, 1920 (A); near Miami, Dade County, *E. J. Palmer*, no. 27476, May 21, 1925 (A); Ft. Myer, *T. G. Harbison*, no. 12, Sept. 17, 1914 (A); between Cocoanut Grove and Cutler, *J. K. Small & J. J. Carter*, no. 718 (isotype?), Nov. 1903 (P); Miami, *H. B. Meredith*, March 14, 1917 (P); Miami, *A. P. Garber*, June–July, 1877 (G. P); Miami, *J. K. Small, J. J. Carter & G. K. Small*, no. 17, Feb. 1911 (P); Florida, *A. W. Chapman* (without locality or date) (P); East Florida, *Dr. Leavenworth* (P).

12. **Amorpha Curtissii** Rydberg in N. Am. Fl. XXIV. 30 (1919).—Fig. 12.

A shrub 1–3 m. high; glabrous or essentially so throughout. Leaves 1–2 dm. long; petioles 1–2 cm. long; leaflets 11–20, oblong or elliptic, 2–4 cm. long, 1–1.5 cm. wide, rounded at both ends or slightly acute at base, and sometimes at apex, dark green above, paler and punctate beneath, firm but thin at maturity. Racemes single or clustered, .5–1.5 dm. long, usually sessile or closely flowered to base; calyx glabrous except the ciliate margins of the lobes, sometimes with a few glands on upper part; calyx-lobes short, the upper two rounded, the lower three triangular and acute; standard dark bluish-purple. Pod 7–8 mm. long, 4 mm. wide, nearly straight dorsally, conspicuously glandular punctate.

North Carolina (?) to Florida.—Type locality: Jacksonville, Florida.

FLORIDA: Jacksonville, *A. H. Curtiss*, no. 4703, May 6, Aug. 21, 1894 (type) (N); Jacksonville, *A. H. Curtiss*, no. 6410, May 20, 1898 (G); vicinity of Mayport and Jacksonville, *Henry D. Keller*, 1870–76 (N); Port Orange, *F. C. Straub*, no. 166, May 2, 1895 (G, N).

SOUTH CAROLINA: Andersonville, *Louis R. Gibbes*, 1885 (N).

NORTH CAROLINA: Wilmington, ex Biltmore Herb., no. 1381L, July 1, 1904 (G).[1]

13. **Amorpha Schwerini** C. Schneider, Ill. Handb. Laubholzk. II. 69, 71 (1907).—Fig. 13.

Amorpha densiflora Boynton in Small, Fl. SE. U. S., ed. 2, 1342 (1913).

A branching shrub 1–2 m. high; branches finely pubescent. Leaves 0.5–1.5 dm. long; petioles about 1 cm. long; leaflets 11–25, oblong or ovate-oblong, 1–4 cm. long, 0.5–1.5 cm. broad, rounded at both ends, slightly emarginate at apex, dark green and short-

[1] The fruit in this specimen is 9–10 mm. long and distinctly curved. In other characters it appears to agree with description of this species.

pilose above, paler and densely soft-pubescent beneath. Calyx 4–6 mm. long, pilose, the lobes all lanceolate, subulate, as long or longer than the tube; standard purple. Pod about 5 mm. long, straight dorsally, punctate and puberulent.

North Carolina and Georgia.—Type locality: Dunn's Mountain, Roan County.

North Carolina: Dunn's Mountain, *J. K. Small*, Aug. 18–27, 1894 (isotype) (N); Crowder's Mountain, ex Biltmore Herb., nos. 14764, 14765b, Sept. 26, 1902, May 14, 1904 (N).

Georgia: Augusta, *C. S. Sargent*, April 29, 1914 (A).

14. **Amorpha paniculata** Torrey & Gray, Fl. N. Am. 1. 306 (1838). —Fig. 14.

Amorpha Roemeriana Scheele in Linnaea, xxi. 461 (1848).

A stout shrub 2–3 m. tall, growing in sandy bogs or wet ground; branchlets sulcate, tomentose. Leaves 2–3.5 dm. long; petioles 4–5 cm. long; leaflets 15–19, oval or oblong, 3–8 cm. long, 1.5–3 cm. wide, rounded at both ends or rarely emarginate at apex, when young finely short-pilose above and densely tomentose beneath, at maturity glabrous and glossy above and still tomentose on lower surface, prominently feather-veined. Calyx oblique, narrow-campanulate, pubescent, the lobes lanceolate, about half as long as the tube; standard purple. Pod 6–8 mm. long, more or less curved dorsally, pubescent and with large resinous glandular dots.

Louisiana and southwestern Arkansas to southern Oklahoma and eastern Texas.—Type locality: Arkansas.

Arkansas: Fulton, *B. F. Bush*, no. 5818, June 10, 1909 (A); McNab, Hempstead County, *E. J. Palmer*, no. 22310, Oct. 12, 1922 (A).

Louisiana: Lecompte, *R. S. Cocks*, no. 116, April, 1901 (A).

Texas: *F. Lindheimer*, no. 37, 1843 (without locality) (G, P); *Drummond expedition*, no. 461 (without locality or date) (A, P); neighborhood Zavala, *Dr. Leavenworth*, July (P); *Wright*, (without locality or date) (G); *Lindheimer*, Brazos, July, 1843 (P); Headwater, *J. Reverchon*, no. 2665, June 18, 1901 (A); Marshall, *B. F. Bush*, no. 991, Oct. 8, 1901 (A); Marshall, Harrison County, *E. J. Palmer*, no. 8635, Sept. 24, 1915 (A); Big Sandy, Upshur County, *E. J. Palmer*, no. 31728, Sept. 27, 1926 (A); Grapeland, Houston County, *E. J. Palmer*, nos. 12829, 14414, Sept. 22, 1917, Sept. 16, 1918 (A).

Cultivated: Arnold Arboretum.

15. **Amorpha texana** Buckley in Proc. Acad. Nat. Sci. Phila. 1861, p. 452 (1862).[1]—Fig. 15.

[1] The original description of this species is as follows:
Amorpha T e x a n a, s. nov.—Fruticosa, foliis magnis, foliolis 4–6-jugis, elliptico-

Amorpha laevigata var. *pubescens* Gray, Pl. Wright. I. 49 (1852).
Amorpha texana var. *mollis* Boynton in Biltmore Bot. Studies, I. 149 (1902).
Amorpha subglabra Heller, Bot. Exped. to Texas, 48 (1925).[1]

A shrub 1–3 m. high, with spreading branches; branches, foliage and inflorescence more or less pubescent. Leaves 1–1.5 dm. long; petioles 1–2 cm. long; leaflets 7–15, broad-oblong or oval, 1.5–4 cm. long, 1.5–3 cm. wide, rounded at both ends or emarginate at apex, sometimes deeply so, firm, dark green and glossy above, paler and pubescent at least along the veins beneath; petiolules 3–5 mm. long, usually pubescent and conspicuously glandular. Flowering racemes single or few, 0.5–1.5 dm. long, rather loosely flowered, at least near the base; rachis pubescent; calyx narrow-campanulate, 4–5 mm. long, more or less pilose-pubescent, glandular; calyx-lobes all much shorter than the tube, the two upper blunt or round, the three lower short-lanceolate, acute; standard blue or violet. Pod 6–7 mm. long, nearly straight dorsally, conspicuously glandular-dotted.

Central and southwestern Texas.—Type locality: on the Pedernales River. Usually found on banks and along beds or rocky streams in the limestone regions.

TEXAS: Dead Man's Hole, on the Pedernales River, *S. B. Buckley* (type), June, 1861 (P); Kerr County, *A. A. Heller*, no. 1772, May 14–21, June 19–26, 1894 (A, G, P); Kerrville, Kerr County, *E. J. Palmer*, nos. 13623, 33826, May 16, 1918, May 7, 1928 (A); Lacey's Ranch, Kerr County, *E. J. Palmer*, no. 10028, June 2, 1918 (A); Spanish Pass, Kendall County, *E. J. Palmer*, no. 9862, May 23, 1916 (A); Fischer's Store, Comal County, *E. J. Palmer*, no. 12193, June 6, 1917 (A); Texas, *Charles Wright*, 1849 (G); Fredericksburg, *F. Lindheimer*, no. 16, June, 1847 (G).

15a. **Amorpha texana** var. **glabrescens**, var. nov.

Amorpha fruticosa var. (1) Gray in Boston Jour. Nat. Hist. VI. (1850).

A typo recedit foliolis glabris vel subglabris.

Central and southwestern Texas.

oblongatis emarginatis mucronatis basi obtusis, breve petiolatis, subtus glanduloso-pubescentibus supra glabris, spicis axillaribus vel capitatis glanduloso-tomentosis, folio parum longioribus, sublaxifloris, floribus breve pedicellatis, calycis dentibus, subaequalibus, ovatis, acutis, stylo exserto villoso, leguminibus subovatis, arcuatis, acutis.

On the Pierdenalis [*sic*] River. June.

Shrub 4–5 ft. high. Racemes and flowers brownish-red; filaments and style long, exserted; leaflets 1–2 inches long and ¾–1¼ wide, the pairs at intervals of about an inch from each other; corolla more than twice the length of the calyx; flowers large in comparison with other species.

[1] Heller's plant, judging by the sheets I have seen of it, appears to be typical *Amorpha texana*, and not the subglabrous plant referred to as a variety of *A. fruticosa* by Gray in Plantae Lindheimerianae, with which he seems to have identified it. For this reason I am using another name for the form of *A. texana* with glabrous leaflets.

TEXAS: New Braunfels, *F. Lindheimer*, no. 743 (type), May, 1850 (A); *Lindheimer*, ex G. W. Short Herb., no. 296, 1849–50 (G, P); Bandera, *J. Reverchon*, no. 1513, June, 1885 (A); Headwaters of the Medina, *J. Reverchon*, no. 42, 1885 (G); Medina Lake, Bandera County, *E. J. Palmer*, no. 12259, June 14, 1917 (A).

16. **Amorpha virgata** Small in Bull. Torrey Bot. Club, XXI. 17 (1894).—Fig. 16.

An erect shrub 1–2 m. high, with single or several stems, usually branching at the summit; branches finely canescent or short pilose when young, becoming glabrous. Leaves 1–2 dm. long; petioles 1.5–2.5 cm. long; leaflets 9–19, oblong or oblong-ovate, often twice as long as wide, 2–5 cm. long, 1–2.5 cm. wide, rounded at both ends or sometimes slightly emarginate at the scarcely mucronate apex; petiolules slender, 3–4 mm. long. Inflorescence usually of several clustered, erect spikes, 1–2 dm. long; standard blue or blue-purple; calyx sparingly villous or canescent at flowering time, glabrous at maturity except the ciliate margins of the lobes; calyx-lobes all much shorter than tube, the two upper obtuse or rounded, the lower triangular and acute. Pod 6–7 mm. long, slightly curved or nearly straight dorsally, usually distinctly keeled, much flattened, glabrous and with rather remote glandular dots.

Florida to Alabama, northward in the Mississippi Valley to southern Illinois, and in the Ozark region of western Arkansas and eastern Oklahoma.—Type locality: Stone Mountain, De Kalb County, Georgia.

FLORIDA: Eustis, *Geo. V. Nash*, no. 261, March 12–31, 1894 (A, G) and no. 1137, July 1–15, 1894 (G, P); Eustis, *T. G. Harbison*, no. 10, June 22, 1919 (A); Sumner, *T. G. Harbison*, no. 8, June 12, 1915 (A); Lake Bersford, Volusia County, *A. H. Curtiss*, no. 6684, July 11, 1900 (G, P); Myers, *A. S. Hitchcock*, no. 52, July-Aug., 1900 (G).

GEORGIA: Stone Mountain, DeKalb County, *J. K. Small*, July 3, 17, 1893 (isotypes) (A, G, P); Stone Mountain, ex Biltmore Herb., no. 14c, May 12, Sept. 8, 1897 (A, G); Stone Mountain, *C. R. Pollard & Wm. R. Maxon*, no. 464, Aug. 10, 1900 (G); McGuire Mill, Gwinnett County, *J. K. Small*, July 17, 1893 (G); "in montibus carolinae et Georgiae," *S. B. Buckley* (P).

ALABAMA: summit of Cheawhan Mountains, Clay County, *Chas. Mohr*, July 31, 1896 (A).

MISSISSIPPI: Byram, *T. G. Harbison*, no. 6, May 24, 1915 (A); West Point, *T. G. Harbison*, no. 7, May 4, 1914 (A); Jackson, *T. G. Harbison*, nos. 59, 61, April 17, 1915 (A).

ARKANSAS: top of Magazine Mountain, Logan County, *E. J. Palmer*, no. 24187, Oct. 17, 1923 (A); Magnet Cove, Hot Springs County, *E. J. Palmer*, no. 26591, Oct. 15, 1924 (A); Hot Springs, Garland County, *E. J. Palmer*, no. 24252, Oct. 20, 1923 (A).

OKLAHOMA: Beachton, McCurtain County, *E. L. Little, Jr. & C. E. Olmstead*, no. 510, July 3, 1930 (A).

CULTIVATED: Arnold Arboretum.

17. **Amorpha croceolanata** Watson, Dendr. II. pl. 139 (1825).—Fig. 17.

Amorpha fruticosa var. b. *croceolanata* C. Schneider, Ill. Handb. Laubholzk. II. 73 (1907).

A stout shrub 2–3 m. high; branchlets furrowed or striate, more or less villous-pubescent, usually copiously so on young growth. Leaves 1.5–2.5 dm. long; petioles 1.5–3 cm. long; leaflets 13–23, oblong or ovate-oblong, 2.5–6 cm. long, 1.5–2.5 cm. broad, rounded at both ends or sometimes slightly cordate at base or emarginate at apex, conduplicate as they unfold and then densely covered with tawny, matted, tomentum, firm but thin at maturity, sparsely villous above and copiously so on lower surface, at least along the veins and on the petiolules. Inflorescence of from one to several erect spikes 1–1.5 dm. long; calyx more or less villous-pubescent, usually copiously so, the lobes all much shorter than the tube, the upper two broadly triangular or rounded, the lower slightly longer and more acute; standard purple blue. Pod 6–7 mm. long, curved dorsally, punctate-dotted and usually pubescent, at least when young.

Florida to Louisiana and northward in the Mississippi valley to southern Illinois and Missouri, and in the southern part of the Ozark region of southern and western Arkansas. Swamps and rocky banks of streams in the coastal plain or piedmont regions.

FLORIDA: Duval County, *A. Fredholm*, no. 5165, May 5, 1902 (A, G); South Jacksonville, Duval County, *J. R. Churchill*, April 13, 1897 (G); Lake County, *Thomas Holm*, March 12, 1893 (G); Duval County, *A. H. Curtiss*, no. 572, April (G, P); St. Marks, *T. G. Harbison*, no. 1505, April 29, 1914 (A); Old Town, Lafayette County, *E. J. Palmer*, no. 27311, May 16, 1925 (A); Bradford, Suwannee County, *R. M. Harper*, no. 155, April 17, 1910 (A, P); Hastings, *Alfred Rehder*, no. 702, April 19, 1920 (A); Florida, *A. W. Chapman* (without locality or date) (G, P).

GEORGIA: Augusta, *C. S. Sargent*, April 6, 1914 (A); Augusta, *T. G. Harbison*, no. 1522, May 4, 1914 (A); Milledgeville, *T. G. Harbison*, no. 1556, May 6, 1914 (A).

ALABAMA: Mobile (without name of collector), Oct. 25, 1839 (G);

Mobile, *Bigelow* (G); Alabama, *Buckley* (without locality or date) (G); Alabama (without name of collector or locality), 1849 (G); Selma, *T. G. Harbison*, no. 577, May 11 (A); Sardis, *T. G. Harbison*, no. 1465, April 23, 1914 (A); Tuscaloosa County, *E. J. Palmer*, no. 35380, April 15, 1929 (A); Demopolis, Marengo County, *E. J. Palmer*, no. 27200, May 14, 1925 (A).

Mississippi: Ocean Springs, *Josephine Skehan*, no. 42, April 1892 (G), and May 8, 1895 (A, G); Tishomingo County, *T. G. Harbison*, no. 21, May 5, 1913 (A).

Louisiana: Chopin, Natchitoches Parish, *E. J. Palmer*, no. 7548, May 6, 1915 (A).

Kentucky: Paducah, McCracken County, *E. J. Palmer*, nos. 17929, 22498, 27341, June 17, 1920, May 3, Sept. 15, 1923 (A).

Missouri: Malden, Dunklin County, *E. J. Palmer*, no. 30317, May 25, 1926 (A).

Arkansas: Faulkner County, *J. T. Buchholz*, no. 948, May 30, 1924 (A); Magnet Cove, Hot Springs County, *E. J. Palmer*, no. 26918, April 24, 1925 (A); Hot Springs, Garland County, *E. J. Palmer*, nos. 23051, 24517, 24909, 26863, June 4, 1923, April 24, May 14, 1924, April 22, 1925 (A): High Point, Garland County, *E. J. Palmer*, no. 24943, May 15, 1924 (A).

Cultivated: Arnold Arboretum and in other American and European gardens.

18. **Amorpha Bushii** Rydberg in N. Am. Fl. xxiv. 31 (1919).—Fig. 18.

A shrub 1–2 m. high; branches sparsely pilose when young, becoming glabrous. Leaves 2–3 dm. long; petioles 3–4 cm. long; leaflets 11–25, oblong, lance-oblong or ovate-oblong, 2–5 cm. long, 1–2 cm. wide, rounded at both ends, or rarely contracted at base or emarginate at apex, remote or at least not crowded on rachis, dark green, dull and glabrous or sparsely short-pilose above, paler and softly pilose beneath. Flowering racemes slender, 1–2 dm. long, usually two or three in cluster; calyx about 4 mm. long, sparingly pilose or nearly glabrous, except the margins of the very short lobes, the upper two of which are rounded or almost obsolete and the three lower short triangular and acutish; standard purple. Pod 6–7 mm. long, straight dorsally, glabrous and sparingly glandular-dotted.

Florida to Louisiana.—Type locality: near Chattahoochee River, Florida.

Florida: near Chattahoochee River, *B. F. Bush*, no. 13 (isotype), Aug. 12, 1897 (A); Chattahoochee River, Gadsden County, *E. J. Palmer*, no. 35263, April 10, 1929 (A); Marianna, Jackson County,

E. J. Palmer, no. 35302, April 12, 1929 (A); Florida, *A. W. Chapman* (without locality or date) (P).

LOUISIANA: Alexandria, *Josiah Hale* (P); Louisiana, *Wm. Carpenter* (without locality or date) (P); Mississippi delta, Panther basin, *Chas. Mohr*, May, 1894 (A).

19. **Amorpha occidentalis** Abrams in Bull. N. Y. Bot. Gard. VI. 394 (1910).—Fig. 19.

A shrub 2–3 m. high; branches and foliage more or less pubescent with short appressed hairs. Leaves 1–2 dm. long; petioles 2–3 cm. long; leaflets 11–27, oblong or elliptic, rounded or abruptly narrowed at base, rounded or rarely abruptly pointed at apex, 1.5–3 cm. long, 0.75–1.5 cm. wide, firm but thin at maturity, dark green and slightly reticulately veined above, paler and sparingly black dotted and more or less pilose, at least along veins beneath, not crowded on rachis. Flowering racemes usually single, slender, 1.5–2.5 dm. long, peduncled, sometimes with one or more additional shorter ones at base; calyx 3–4 mm. long, nearly glabrous or slightly pilose on tube; calyx-lobes all much shorter than the tube, the upper two broad and obtuse, the lower three triangular, acute, villous or ciliate along the margins; standard dark blue. Pod 6–7 mm. long, slightly curved dorsally, glabrous and conspicuously glandular-dotted.

Wyoming and western Texas to Arizona, California and northern Mexico.—Type locality: San Diego River, near Old Mission, California.

CALIFORNIA: Torrey Pines Park, San Diego County, *Philip A. Munz*, no. 1953, May 9, 1924 (G); Pipe Creek, Hemet Valley, San Jacinto Mts., *Mary F. Spencer*, no. 2191, Aug. 17, 1923 (G); San Diego County, *Edward Palmer*, no. 65, 1875 (G); San Diego River, near Old Mission, *LeRoy Abrams*, no. 3425 (isotype), May 6, 1903 (A, G, P); Wilson Creek, San Diego County, *LeRoy Abrams*, no. 4917, July 11, 1912 (A); San Diego, *C. S. Sargent*, Sept. 18, 1894 (A); San Bernardino, *S. B. & W. F. Parish*, no. 147, April 1881 (A); Waterman Cañon, San Bernardino Mts., *S. B. Parish*, no. 11379, June 14, 1917 (A); Cuyamaca, San Diego County, *Alice Eastwood*, no. 9139, June 25, 1919 (A); Coachella, Riverside County, *Philip A. Munz*, no. 10841, May 2, 1927 (A); San Jacinto Mts., *H. M. Hall*, no. 2121, June, 1901 (P).

WYOMING: Platte Cañon, Laramie County, *Aven Nelson*, no. 8651, Sept., 1901 (G).

TEXAS: Boerne, *S. H. Hastings*, 1911 (A); vicinity of El Paso, *Elmer Stearns*, no. 116, 1911 (A); New Braunfels, *H. A. Pilsbry*,

April 17–19, 1903 (P); Tarrent Co., *Albert Ruth*, no. 21, May 5, 1919 (P).

New Mexico: Tierra Blanca, *Mrs. I. M. Beals*, 1904 (G); Kingston, *O. B. Metcalf*, no. 930, May 24, 1904 (A); Cliff, Grant County, *O. B. Metcalf*, no. 133, June 13, 1903 (G); Upper Gila River, *E. L. Greene*, no. 126, May 27, 1880 (G); Albuquerque, Bernalillo County, *E. J. Palmer*, no. 31129, June 20, 1926 (A).

Arizona: San Pedro Valley, *L. N. Gooding*, no. 53a, April, 1908 (G); Summit Ranch, Lectanes Plateau, *L. N. Gooding*, no. 705, July 28, 1910 (G); Willow Springs, *J. T. Rothrock*, no. 244, 1874 (G); Stephens Ranch, *Miss Bettina Stephens*, June 24, 1907 (G); Bonito Cañon, *J. S. Blummer*, no. 1292, Aug. 19, 1906 (G); Santa Catalina Mts., *Alfred Rehder*, no. 261, Aug. 1914 (A); Cave Creek Cañon, Chiricahua Mts., *J. W. Toomey*, July, 1894 (A); Santa Rita Mts., *C. G. Pringle*, May 5, 1881 (P); Arizona (without locality), *C. G. Pringle*, June 5, 1884 (P).

Mexico: Sonora, *Geo. Thurber*, no. 351, June 1851 (G).

19a. **Amorpha occidentalis** var. **emarginata**, var. nov.—Fig. 19a.

A typo recedit foliolis brevioribus apice truncatis vel retusis, glabratis vel subglabratis.

Arizona and southern California.—Type locality: Fish Creek, Apache Trail, Arizona.

California: Banning, San Diego County, *F. G. Woodcock*, no. 1628, April, 1922 (A); San Diego, *Mary F. Spencer*, no. 1442, April 25, 1926 (G).

Arizona: Fish Creek, Apache Trail (Cochise Co.?), *Alice Eastwood*, no. 8745, May 19, 1919 (type) (A); road to Pleasant Valley, Sierra Hucha, *Susan D. McKelvey*, no. 1183, May 30, 1929 (A).

19b. **Amorpha occidentalis** var. **arizonica**, comb. nov.—Fig. 19b.

Amorpha arizonica Rydberg in N. Am. Fl. xxiv. 33 (1919).

Differs from the type only in the looser and more copious pubescence of the branches, foliage and inflorescence.

Arizona and New Mexico.—Type locality of *Amorpha arizonica* Rydb.: Ramsey Cañon, Huachuca Mts., Arizona.

Arizona: Ramsey Cañon, Huachuca Mts., *L. N. Gooding*, no. 136 (isotype), June 10, 1909 (G).

20. **Amorpha fruticosa** Linnaeus, Spec. Pl. 713 (1753).—Fig. 20.

Amorpha perforata Schkuhr, Handb. II. 333 (1796).
Amorpha nonperforata Schkuhr, l. c.
?Amorpha arborea Hort. ex Schkuhr, l. c.; nomen nudum.
Amorpha fruticosa α. vulgaris Pursh, Fl. Am. Sept. II. 466 (1814).
?Amorpha elata Hayne, Dendr. Fl. 134 (1822).
Amorpha ornata Wenderoth, Ind. Sem. Hort. Marb. (1838); nomen nudum.

?Amorpha herbacea Schlechtendal, Ind. Sem. Hort. Hal. 8 (1848), nomen nudum.—Not *A. herbacea* Walt.

Amorpha pubescens Schlechtendal in Linnaea, XXIV. 691 (1851).—Not *A. pubescens* Willd.

Amorpha Ludvigii Hort. ex K. Koch, Dendr. I. 70 (1869), nomen nudum.

Amorpha fruticosa var. a *typica* C. Schneider, Ill. Handb. Laubholzk. II. 72 (1907).

A shrub 2–4 m. high, or rarely higher; branches striate, more or less strigose or pilose. Leaves 0.7–2 dm. long, usually ascending; petioles 1–2 cm. long; leaflets 9–25, oblong, elliptic or slightly ovate, rounded or abruptly pointed at both ends, or in forms sometimes cuneate at base, or emarginate at apex, usually finely pubescent above and more or less densely villous beneath when young, at maturity dull green and glabrous above, slightly paler and still pubescent, at least along the veins, beneath; petiolules 2–3 mm. long. Inflorescence usually of several clustered, erect, closely-flowered spikes 1–1.5 dm. long; calyx sparingly pilose, becoming glabrous in age except the ciliate margins of the lobes; calyx-lobes all much shorter than the tube, the two upper ones very blunt or rounded, the lower ones acute; standard purplish-blue, varying to pale blue or white in forms. Pod 7–8 mm. long, more or less curved dorsally, glabrous and marked by large resinous dots.

? Connecticut to Alabama and westward to Minnesota and Oklahoma.

Naturalized in the northeastern states and also in Europe and western Asia.

In cultivation since the eighteenth century and passing into several more or less distinct varieties and a number of forms, which have been distinguished in horticulture and in a wild state.

MASSACHUSETTS (introduced): vicinity of Woods Hole, *John M. Fogg, Jr.*, June 25, 1923 (P); Mystic Pond, Arlington, *C. K. Knowlton*, June 18, 1898 (G); Boston, Back Bay, *F. E. Williams*, Sept. 17, 1910 (G); Boston, Fenway, *Arthur Stanley Pease*, no. 9831, Oct. 9, 1906 (G).

NEW HAMPSHIRE (introduced): Lake Winnepesaukee, *Alfred Rehder*, no. 1081, Aug. 16, 1927 (A).

PENNSYLVANIA: Henderson Station, Montgomery County, *Jas. Crawford*, June 1, 1895 (P); Strafford, Chester County, *Edwin B. Bartram*, no. 1517, June 11, 1911 (A).

DISTRICT OF COLUMBIA: waste ground, *E. S. Steele*, May 28, 1898 (A).

NORTH CAROLINA: Salem, ex Schweinitz Herb. (P); Wilmington, *C. S. Williamson*, Aug. 1892 (P).

ALABAMA: ex Torrey Herb. (without locality or date) (G).

MISSISSIPPI: Yazoo City, *T. G. Harbison*, no. 25, May 1, 1915 (A).

OHIO: Cleveland, *L. D. Starr*, no. 6254, May 19, 1896 (G).

INDIANA: Shelby, Lake County, *C. C. Deam*, no. 20134, June 6, 1916 (G); Monroe, Knox County, *C. C. Deam*, no. 38676, June 4, 1923 (A); Decker, Knox County, *C. C. Deam*, no. 17050, July 8, 1915 (A); Cannelton, Perry County, *C. C. Deam*, no. 16616, June 29, 1915 (A); North, Ohio County, *C. C. Deam*, no. 48553, May 29, 1930 (A).

ILLINOIS: Port Byron, *E. T. & S. A. Harper*, June 1898 (A); Salem, *M. S. Bebb*, 1860 (G); Fountaindale, *M. S. Bebb*, 1870 (G); Davenport, La Salle County, *J. M. Greenman, O. E. Lansing, Jr. & R. A. Dixon*, no. 136, June 1–7, 1909 (G); Grand Tower, *Allen Gleason*, no. 1786, Aug. 17, 1900 (G); Starved Rock, La Salle County, *J. M. Greenman, O. E. Lansing, Jr. & R. A. Dixon*, no. 14, June 1–7, 1909 (G); *H. C. Skeels*, no. 628, May 30, 1905 (G); Aurora, *T. E. Boyce*, no. 572, June 1, 1884 (G); Peoria, *F. E. McDonald*, May 1904 (G); Cairo, Alexander County, *E. J. Palmer*, no. 23767, Sept. 17, 1923 (A); Aurora, *F. L. Bassett*, 1881 (P).

KENTUCKY: Brandenberg, *C. W. Short*, 1842 (P); Wickliffe, *Frank T. McFarland & W. A. Anderson, Jr.*, no. 189, Aug. 17, 1923 (A); Owensboro, Daviess County, *E. J. Palmer*, no. 17821, June 10, 1920 (A).

TENNESSEE: Memphis, *A. Fendler*, May 10, 1851, Aug. 28, 1853, 1855 (G); Reelfoot Lake, *Samuel L. Bain*, no. 402, June, 1903 (G).

MINNESOTA: St. Anthony, *J. H. Schuette*, June 2, 1888 (G); Swan Lake, Nickolet County, *C. A. Ballard*, June, 1892 (G); Lake City, *Warren H. Manning*, June 25, 1883 (G); St. Paul, ex Charles E. Smith Herb., June, 1872 (P).

IOWA: Ames, *C. R. Ball & Royal Meeker*, no. 525, June 21, 1897 (G); Carroll, *L. H. Pammel*, July 2, 1898 (G).

MISSOURI: Kennett, *C. S. Sargent & Wm. Trelease*, April 24, 1897 (A); Grain Valley, *B. F. Bush*, no. 10498, May 28, 1926 (A); Monteer, *B. F. Bush*, no. 9846, Aug. 5, 1922 (A); Dumas, *B. F. Bush*, no. 5922, Aug. 8, 1908 (A); Allenton, *Geo. W. Letterman*, 1897 (A, P); Creve Coeur Lake, St. Louis County, *Moses Craig*, June, 1909 (A); Galena, Stone County, *E. J. Palmer*, no. 5702, May 21, 1914; Novinger, Adair County, *E. J. Palmer*, no. 25545, June 16, 1924 (A); Monticello, Lewis County, *E. J. Palmer*, no. 35907, May 20, 1929 (A); Osceola, St. Clair County, *E. J. Palmer*, no. 35653, May 6, 1929 (A); Hickory County, *E. J. Palmer*, no. 35979, May 22, 1929 (A); Joplin, Jasper County, *E. J. Palmer*, no. 22891, May 28, 1923 (A); Alba, Jasper County, *E. J. Palmer*, nos. 4350, 30106, Sept. 16, 1913, May 15, 1926 (A); Forest Mill, Jasper County,

E. J. Palmer, no. 25323, June 4, 1924 (A); Columbus, Johnson County, *E. J. Palmer*, no. 36646, June 21, 1930 (A).

ARKANSAS: Decatur, Benton County, *D. Demaree*, no. 4644, Oct. 15, 1927 (A); War Eagle, Benton County, *D. Demaree*, no. 5429, Sept. 16, 1928 (A); Avoca, Benton County, *D. Demaree*, no. 6664, May 17, 1929 (A); Greenland, Washington County, *D. Demaree*, no. 3025, May 12, 1927 (A); Fayetteville, Washington County, *E. J. Palmer*, no. 23262, June 13, 1923 (A); Midway, Sebastian County, *E. J. Palmer*, no. 33281, April 8, 1928 (A); Magazine Mountain, Logan County, *E. J. Palmer*, no. 23242, June 11, 1923 (A); Little Rock, Pulaski County, *E. J. Palmer*, no. 24443, April 21, 1924 (A); Mesa, Prairie County, *E. J. Palmer*, no. 25071, May 22, 1924 (A); Hot Springs, Garland County, *E. J. Palmer*, nos. 24907, 29136, May 14, 1924, Oct. 11, 1925 (A); Fulton, *B. F. Bush*, no. 2451, April 26, 1905 (A).

KANSAS: Augusta, *S. F. Poole*, no. 23, May, 1903 (G); Neodesha, Wilson County, *E. J. Palmer*, nos. 21163, 21396, May 5, 23, 1922 (A); Arkansas City, Cowley County, *E. J. Palmer*, no. 21233, May 11, 1922 (A); Downs, Osborn County, *E. J. Palmer*, no. 21336, May 20, 1922 (A); Ellsworth, Ellsworth County, *E. J. Palmer*, no. 21270, May 13, 1922 (A); Harper, Harper County, *E. J. Palmer*, no. 21199, May 8, 1922 (A).

MISSISSIPPI: Yazoo City, *T. G. Harbison*, no. 25, May 1, 1915 (A).

Plants that are assigned to this species and its varieties vary greatly in the size, shape, and number of the leaflets, and in the amount of pubescence, as well as to some extent in the shape and size of the fruit. Species based upon slight differences in these characters, such as *Amorpha fragrans* Sweet and *Amorpha tennesseensis* Shuttl., although appearing distinct in extreme forms, are often indistinguishable, as there is a complete gradation of intermediate forms, and it seems best therefore to treat them as varieties of one species. *Amorpha occidentalis* of the Pacific coast and the Southwest and *A. croceolanata* of the Gulf coastal plain are also closely related to *A. fruticosa*, the former not always easily distinguishable morphologically from *A. fruticosa* var. *angustifolia;* and while the latter is more outstanding from the character of its pubescence and the size and shape of the leaflets, it is a matter of opinion whether they should be regarded as distinct species, as they are treated in this paper, or as varieties of *A. fruticosa*, as has been done by some authors.

The following forms have been distinguished, mostly based on cultivated plants:

Amorpha fruticosa f. albiflora Sheldon in Bull. Geol. Surv. Minn. IX. 72 (1894).

Flowers white. This form is found also in cultivation.

Amorpha fruticosa f. pendula C. Schneider, Ill. Handb. Laubholzk. II. 73 (1907).

Amorpha pendula Carrière in Rev. Hort. 1869, 340.
Amorpha fruticosa b. *pendula* Dippel, Laubholzk. III. 691 (1893).

Distinguished by its slender recurved branches. Occasionally cultivated in American and European gardens.

Amorpha fruticosa f. crispa C. Schneider, Ill. Handb. Laubholzk. II. 72 (1897).

Amorpha fruticosa var. *crispa* Kirchner, Arb. Musc. 370 (1864).

Distinguished by the crisped margins of the leaves. In cultivation.

Amorpha fruticosa f. humilis, comb. nov.

Amorpha humilis Tausch in Flora, XXI. 750 (1838).
Amorpha fruticosa var. c. *humilis* C. Schneider, Ill. Handb. Laubholzk. II. 73 (1907).

A low form, often dying back to the ground each season. In cultivation.

Amorpha fruticosa f. coerulea, comb. nov.

Amorpha coerulea Lodd. Cat. (1830) ex Loudon, Arb. Brit. II. 607 (1838), nomen nudum.
Amorpha fruticosa var. 5. *coerulea* Loudon, Arb. Brit. II. 607 (1838).

A form in cultivation and sometimes found growing spontaneously with the type, from which it is distinguished by its pale blue flowers.

Amorpha fruticosa f. aureo-variegata Schwerin in Mitteil. Deutsch. Dendr. Ges. XVI. 255 (1907).

A form in cultivation, with variegated foliage.

20a. **Amorpha fruticosa** var. **angustifolia** Pursh, Fl. Am. Sept. 466 (1814).—Fig. 20a.

Amorpha nana Sims in Bot. Mag. XLVII. t. 2112 (1819).—Not Nuttall.
Amorpha fragrans Sweet, Brit. Fl. Gard. III. t. 241 (1828).
Amorpha Lewisii Lodd. Cat. (1830), ex Loudon, Arb. Brit. II. 607 (1838).
Amorpha fruticosa 4. *Lewisii* Loudon, Arb. Brit. II. 607 (1836).
Amorpha angustifolia Boynton in Biltmore Bot. Studies, I. 139 (1902).

Differs from the type in its usually narrower elliptic leaflets, narrowed or cuneate at the base, and in the more sparse, appressed, pubescence.

Wisconsin and Minnesota to Saskatchewan and southward to Kansas, Texas and northern Mexico. Occasionally escaped farther east.

MASSACHUSETTS (introduced): Boston, *Charles F. Batchelder*, June 8, 1918 (G).

WISCONSIN: St. Croix Falls, *C. F. Baker*, July 16, 1900 (G); Alma, Buffalo County, *E. J. Palmer*, no. 27833, June 10, 1925 (A); Fountain City, Buffalo County, *Huron H. Smith*, no. 7196, July 8, 1922 (A).

MINNESOTA: Cannon Falls, *J. H. Sandberg*, no. 357. July, 1891 (A).

NORTH DAKOTA: Bismarck, *Esther L. Larsen*, no. 171, Aug. 14, 1927 (G).

SOUTH DAKOTA: Missouri River Valley, Union County, *W. R. Wilcox*, Aug. 27 (A); Cottonwood Creek, Bad River, *T. A. Williams*, (G); Sioux Falls, *T. A. Williams*, June 5, 1896 (A); Big Stone, *T. A. Williams*, no. 161, Aug. 15, 1894 (A); Rapid City, Pennington County, *E. J. Palmer*, no. 37318, June 16, 1929 (A); Hot Springs, Fall River County, *E. J. Palmer*, no. 37440, June 21, 1929 (A); Pine Ridge Indian Reservation, Washabaugh County, *E. J. Palmer*, no. 37638, June 29, 1929 (A).

NEBRASKA: Thedford, Thomas County, *P. A. Rydberg*, no. 1314, Sept. 8, 1893 (G); Red Cloud, *J. M. Bates*, no. 2263, June 22, 1903 (G); Ponca, *Fred Clements*, no. 2538, June 14, 1893 (G); Butler County, opposite Columbus, *E. J. Palmer*, no. 36063, June 5, 1929 (A).

MISSOURI: Grain Valley, *B. F. Bush*, no. 6992, May 24, 1913 (A).

KANSAS: Osburn City, Osburn County, *C. L. Shear*, nos. 45, 168, May 26, July 20, 1894 (G); Riley County, *J. B. S. Norton*, nos. 89, 89a, 1895, 1896 (G).

COLORADO: Ft. Collins, *C. S. Crandall*, no. 1241, June 12, 1896 (G, P); no. 15, June 14, Oct. 3, 1893 (G); Wolhurst, Douglas County, *I. W. Clokey*, no. 3802, July 8, 1920 (G, P); Ft. Collins, *J. H. Cowan*, no. 127, June 13, 1895 (G).

ARKANSAS: Marion County, opposite Cotter, *E. J. Palmer*, no. 5935, June 12, 1914 (A).

OKLAHOMA: Fonts, Lincoln County, *Clara Nevins*, May 5, 1895 (G); Tulsa, Tulsa County, *G. W. Stevens*, no. 2993, Oct. 30, 1913 (A, G); Knowles, Beaver County, *G. W. Stevens*, no. 520, May 19, 1913 (A, G); Pawhoska, Osage County, *G. W. Stevens*, no. 1937, Aug. 8, 1913 (A, G); Page, Le Flore County, *G. W. Stevens*, nos. 1393, 2620, April 20, Sept. 6, 1913 (G); Canton, *D. M. Andrews*, Aug. 15, 1915 (A); along Little River, Pushtamaha County, *E. L. Little, Jr. & C. E. Olmstead*, no. 536, July 5, 1930 (A); Sapulpa, *B. F. Bush*, no. 1105, May 1, 1895 (A); Youkon, Canadian County,

E. J. Palmer, no. 22134, Sept. 29, 1922 (A); Tishomingo, Johnston County, *E. J. Palmer*, no. 6441, Sept. 8, 1914 (A); Sapulpa, *C. B. Williams*, May 21, 1924 (P).

New Mexico: *A. Fendler*, no. 126, 1847 (G); Kingston, *O. B. Metcalf*, no. 930, May 24, 1904 (G).

Arizona: Willow Springs, *Edward Palmer*, no. 484, June 10–20, 1890 (G).

Texas: *F. Lindheimer* (without locality), nos. 595, 1847 (G, P); 742, 1850 (G, P); *V. Havard*, nos. 2, 3 (without locality), July, 1881 (G); Texas, *Charles Wright* (without locality or date) (G); Cibilo Creek, *V. Havard*, no. 1, May, 1881 (G); Burton, *Elihu Hall*, no. 127, May 26, 1872 (G, P); Kerrville, *A. A. Heller*, no. 1596, April 19–25, June 26–30 (A, G, P); Dallas, *J. Reverchon*, no. 223, June, Sept. 1880 (A); Dallas, *J. Reverchon*, no. 145, May, 1874 (G); Austin, *M. S. Young*, no. 38, April 15, 1918 (G); Kinney County, *V. L. Corey*, no. 377, April 17, 1929 (G); White's Ranch, Chambers County, *B. C. Tharp*, no. 3138, Sept. 3, 1924 (A); Dallas, *B. F. Bush*, no. 692, May 10, 1900 (A); Southeast Texas, *E. N. Plank* (A); *Lincecum* (without locality or date) (P); Kerrville, Kerr County, *E. J. Palmer*, no. 33827, May 7, 1929 (A); Tivoli, Refugio County, *E. J. Palmer*, no. 9253, March 22, 1916 (A); San Saba, San Saba County, *E. J. Palmer*, no. 11822, May 5, 1917 (A); Devil's River, Valverde County, *E. J. Palmer*, no. 11387, March 26, 1917 (A); Gamble's Ranch, Armstrong County, *E. J. Palmer*, no. 13967, June 6, 1918 (A); Brownwood, Brown County, *E. J. Palmer*, no. 26798, Oct. 31, 1924 (A); Sweetwater, Nolan County, *E. J. Palmer*, no. 33975, May 15, 1928 (A).

Manitoba: *John Macoun*, no. 12511, Aug. 7, 1896 (G).

Mexico: Casas Grandes, Chihuahua, *E. A. Goldman*, no. 405, May 12, 1899 (G); Paso del Norte, Chihuahua, *C. G. Pringle*, no. 1221, May 10, Aug. 12, 1887 (G, P).

Cultivated for many years in American and European gardens, often under the name *Amorpha Lewisii*.

Amorpha fruticosa var. **angustifolia** f. **glabrata**, forma nov.

A typo varietatis recedit ramulis foliisque glabris vel fere glabris.

Texas: Kurten, Brazos County, *E. J. Palmer*, no. 13479 (type), April 28, 1918 (A).

A plant that may be referred to this form which differs from typical var. *angustifolia* in the branches and foliage being nearly or entirely glabrous, is in cultivation at Highland Park, Rochester, N. Y. A specimen collected by E. H. Costich, July 17, 1915, bears the notation: "very late flowering." (A).

20b. **Amorpha fruticosa** var. **tennesseensis**, comb. nov.—Fig. 20b.

Amorpha tenesseensis Shuttleworth in Kunze, Delect. Sem. Hort. Lips. 1848, p. 1 adn. ex Walpers, Ann. Bot. Syst. II. 360 (1851); Linnaea, XXIV. 191 (1851).

Differs fron the type in the often more numerous, narrow-oblong leaflets, and in the slightly curved or nearly straight pod.

North Carolina to Florida and west to Kansas, Oklahoma and Texas.—Type locality: Dandridge, Tennessee.

NORTH CAROLINA: Swain County, *H. C. Beardsley & C. O. Kofoid*, July 17, 1891 (G); Falls of Yadkin River, Stanley County, *J. K. Small*, Aug. 18, 1892 (G).

TENNESSEE: Dandridge, *Rugel*, June–Sept., 1842 (isotype) (G); Ocoee River, Polk County, no. 1381a, ex Biltmore Herb., Oct. 5, 1897 (G); Cleveland, *E. E. Magee*, Oct. 1, 1897 (G).

ILLINOIS: Fall Creek, Adams County, *J. Davis*, no. 3226, Sept. 16, 1894 (A); Wady Petra, *Virginius H. Chase*, no. 737, Aug. 14, 1900 (P).

KENTUCKY: Eddyville, Lyons County, *E. J. Palmer*, no. 32712, Sept. 14, 1923 (A).

MISSOURI: Joplin, Jasper County, *E. J. Palmer*, nos. 21956, 21968, Sept. 14, 1922 (A); Noel, McDonald County, *E. J. Palmer*, no. 4156, Sept. 16, 1918 (A); Branson, Taney County, *E. J. Palmer*, no. 19232, Sept. 29, 1920 (A).

ARKANSAS: Van Buren, *G. M. Brown*, Aug. 8, 1909 (A); Baker Springs, Howard County, *J. H. Kellogg*, Oct. 5, 1909 (A); Blue Mountain, Logan County, *E. J. Palmer*, no. 24217, Oct. 18, 1923 (A); Hot Springs, Garland County, *E. J. Palmer*, no. 24251, Oct. 20, 1923 (A); Mesa, Prairie County, *E. J. Palmer*, no. 24333, Oct. 24, 1923 (A).

KANSAS: Galena, Cherokee County, *E. J. Palmer*, no. 21979, Sept. 15, 1922 (A); Neodesha, Wilson County, *E. J. Palmer*, no. 22033, Sept. 19, 1922 (A); Arkansas City, Cowley County, *E. J. Palmer*, no. 22073, Sept. 26, 1922 (A); Ellsworth, Ellsworth County, *E. J. Palmer*, no. 38163, Aug. 3, 1930 (A).

OKLAHOMA: Page, LeFlore County, *G. W. Stevens*, no. 2620, Sept. 6, 1913 (A); Page, LeFlore County, *E. J. Palmer*, nos. 20601, 22259, Sept. 23, 1921, Oct. 10, 1922 (A); Hugo, Choctaw County, *E. J. Palmer*, no. 24068, Oct. 7, 1923 (A).

ALABAMA: Cullman, *T. G. Harbison*, no. 3, Nov. 3, 1919 (A); Alabama, *Buckley* (without locality or date) (G).

CULTIVATED: Arnold Arboretum.

20c. **Amorpha fruticosa** var. **oblongifolia**, var. nov.—Fig. 20c.

A typo recedit foliolis oblongis vel lineari-oblongis, 20–50 mm.

longis, 8–16 mm. latis, glabris vel infra minute scabro-pubescentibus.

An erect shrub 2–3 m. high. Leaves 1.5–2.5 dm. long; petioles 2–3 cm. long; leaflets 21–41, oblong or narrowly oblong, 2–5 cm. long, 0.5–1.5 cm. wide, rounded at both ends or slightly emarginate at mucronate apex, and rarely abruptly narrowed at base, thin but firm, dark green and glossy above, much paler or sometimes slightly glaucous, black-punctate and glabrous or sparsely scabrous-pubescent beneath; petiolules slender, 1.5–2 mm. long. Inflorescence of a few or several erect spikes 0.8–2 dm. long; calyx glabrous, its lobes much shorter than the tube, the two upper ones low and rounded, the lower broadly triangular. Pod 7–9 mm. long, 3 mm. wide, somewhat curved dorsally, with short erect beak, glandular dotted.

Missouri and Arkansas. Type locality: Helena, Phillips County, Arkansas.

Missouri: Watson, Atchison County, *E. J. Palmer*, no. 19010, Sept. 4, 1920 (A); Purcell, Jasper County, *E. J. Palmer*, no. 22182, Oct. 3, 1922 (A).

Arkansas: Marion County, opposite Cotter, *E. J. Palmer*, no. 20659, Oct. 3, 1921 (A); Helena, Phillips County, *E. J. Palmer*, no. 26628 (type) Oct. 17, 1924 (A); Forrest City, St. Francis County, *E. J. Palmer*, no. 29278, Oct. 17, 1925 (A).

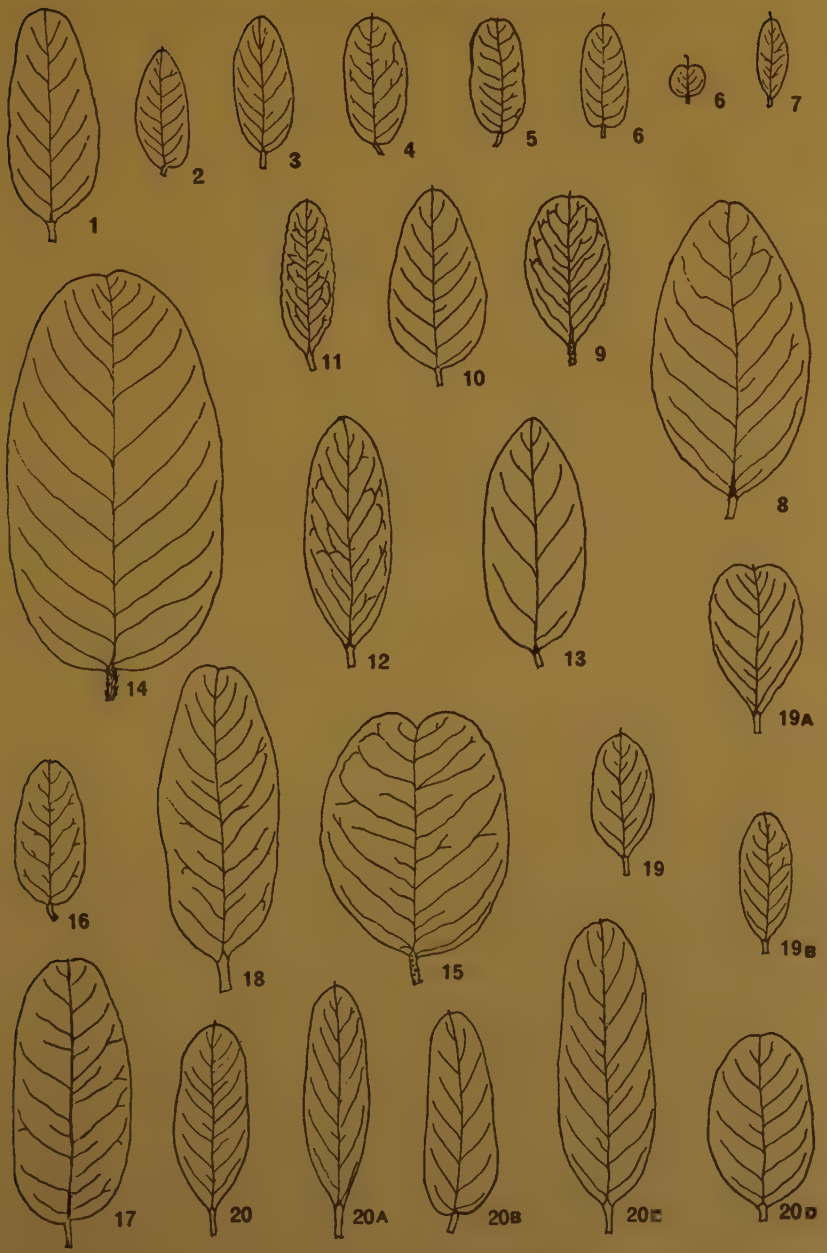
This is a very distinct looking variety, on account of its numerous, crowded, narrowly oblong leaflets. It may when better known prove to be a distinct species, but it seems safest at present to treat it as a variety of the polymorphous species *A. fruticosa*, since I have not seen the flowers and some of the specimens in which the leaf characters are best marked are without fruit, while certain specimens of *A. fruticosa* or the var. *tennesseensis* approach it. The leaflets in shape and number resemble most closely those of *A. fruticosa* var. *tennesseensis*, but they are usually much larger and differ in being glabrous or sparingly short-pilose or scabrate. The essentially glabrous branches and leaf rachises and the glabrous calyx also serve to distinguish it. The leaflets also resemble in size, shape, and texture those of *A. Bushii*, but they differ from those of the southeastern species in the absence of loose villous pubescence as well as in the shape of the fruit. The calyx in *Amorpha fruticosa* var. *oblongifolia* is entirely glabrous, at least in fruiting specimens, and the teeth are almost as short as in *A. glabra*. The fruit is slightly larger than in typical *A. fruticosa*, but is similarly curved on the back.

20d. **Amorpha fruticosa** var. **emarginata** Pursh, Fl. Am. Sept. II. 466 (1814).—Fig. 20d.

Amorpha emarginata Sweet, Hort. Brit. ed. 1, 121 (1827).

FRUITS OF AMORPHA (× 5 ½–6)

(The figure numbers correspond with the numbers of the species in the text)



LEAFLETS OF AMORPHA (XI)

(The figure numbers correspond with the numbers of the species in the text)

Differs from the type in the usually larger, oval or ovate leaves, blunt or emarginate at the apex.

Mississippi to Arkansas and Illinois.

ILLINOIS: Crawford Bridge, Macon County, *I. W. Clokey*, no. 2382, May 31, 1915 (G); Decatur, *I. W. Clokey*, no. 2703, May 29, 1899 (G); Decatur, *Allan Gleason*, no. 825, May 21, 1899 (G); Mahomet, *Allan Gleason*, no. 2414, May, 1901 (G); Cairo, Alexander County, *E. J. Palmer*, no. 15082, May 8, 1919 (A).

MISSOURI: Webb City, *B. F. Bush*, no. 553, May 20, 1901 (A).

ARKANSAS: Newport, Jackson County, *E. J. Palmer*, no. 35528, April 26, 1929 (A).

TENNESSEE: cliffs of Cumberland River, Nashville, *A. Gattinger*, no. 130 (A); Shepards, Haywood County, *E. J. Palmer*, no. 17470, May 13, 1920 (A).

Cultivated in American and European gardens.

This variety is in some respects intermediate between typical *Amorpha fruticosa* and *A. croceolanata*, somewhat resembling the latter in the shape and size of the leaflets, but differing in its gray, less copious pubescence.

DOUBTFUL SPECIES AND VARIETIES, AND NAMES EXCLUDED FROM THE GENUS

Amorpha caroliniana Croom in Am. Jour. Sci. XXV. 74 (1834).

No specimens have been seen which agree with the original description. See remarks under 4. *A. cyanostachya* M. A. Curtis on p. 170.

Amorpha fruticosa var. *fragrans* Bean, Trees & Shrubs, I. 193 (1914).

From the brief description this is apparently not identical with *A. fruticosa* var. *angustifolia* (*A. fragrans* Sweet). Undeterminable.

Amorpha fruticosa β *pumila* Wenderoth in Schrift. Ges. Beförd. Naturw. Marburg, II. 259 (1831). This may possibly be the same as *A. humilis* Tausch (= *A. fruticosa* f. *humilis*), but description is too indefinite to show clearly to what form it refers.

Amorpha Gaertnerii Hort. ex K. Koch, Dendr. I. 70 (1869), nomen nudum.

Amorpha Gardnerii Hort. ex Kirchner, Arb. Musc. 370 (1864), nomen nudum.

Amorpha glandulosa Blanco, Fl. Philipp. ed. I. 553 (1837) = PAROSELA GLANDULOSA (Blanco) Merrill in Philipp. Jour. Sci. v. 68 (1910).

Amorpha lutea Rafinesque, Fl. Ludov. 105 (1817). Undeterminable and apparently does not belong to the genus.

Amorpha pedalis Blanco, Fl. Philipp. ed. I. 555 (1837) = SOLOMONIA CILIATA (L.) DC., fide Merrill, Spec. Blanc. 214 (1918).

Amorpha Rabiae Lexarza in Lexarza & La Llavé, Nov. Veg. Desc. fasc. I. 22 (1824).[1]

Amorpha tomentosa ? Rafinesque, Fl. Ludov. 105 (1817). Undeterminable and probably not an Amorpha.

Amorpha crocea, *A. dealbata*, *A. elatior*, *A. ludoviciana*, *A. marginata* Hort. ex Lavallée, Arb. Segrez. 60 (1877), nomina nuda.

ON THE OCCURRENCE OF CASUARINA NODIFLORA FORST. IN AUSTRALIA

C. G. G. VAN STEENIS

Casuarina nodiflora Forster, Fl. Ins. Austr. Prodr. 64 (1716).

NORTHEAST QUEENSLAND: Mt. Alexander, collected for the Arnold Arboretum by *S. F. Kajewski*, no. 1492 (Arnold Arb. Exped.), Feb. 17, 1929 (small tree up to 7 m. high, common in poor scrub on top of the mountain).

This species is somewhat variable in habit, the specimen being a mountain form with densely crowded short branchlets. It differs from most other specimens by the short ferrugineous pubescence remaining on the bracts as well as on the bracteoles of the fruiting cones. In other specimens this short tomentum is more scanty and soon disappears in the fruiting state.

I can find no sound differences between this and the East-Malaysian *C. Rumphiana* Miq. which in my eye ought to be referred to *C. nodiflora* Forst. as a synonym. If this is adopted the area of *C. nodiflora* adequately extends from the Fiji Islands, New Caledonia, Queensland and New Guinea to the Moluccas, Selebes (Celebes) and Philippines and overlaps the area of *C. sumatrana* Jungh.

The cones of the Malaysian specimens are usually described as much smaller but it should be borne in mind that also in immature cones the bracteoles spread when dried, except in the extremely young ones. In those opened immature cones the bracteoles are much less thickened than in the ripe ones and the unripe fruits are more or less wrinkled. I doubt whether the cones and fruits are fully developed in this specimen. Prof. L. Rutten collected the species in Central Séran (Ceram) at 1400 m. altitude and his specimen shows the same crowded mountainous habit as that collected by Kajewski.

HERBARIUM, BUITENZORG, JAVA

[1] A synopsis of the author's description of this species is as follows:
Herbaceous ?, 2 ft. high; stems terete, smooth; leaflets ovate, acute, tomentose; racemes axillary, fascicled; bracts short, acute; calyx cup-shaped, obscurely 6-lobed [!], tomentose without; calyx-lobes obtuse; standard obovate or cuneiform, white, slightly keeled; ovary covered with lanate or silky tomentum; style short, incurved; pod one-seeded, glandular; seed reniform.
The type specimen was collected on Mount Quinceo, in the state of Michoacan, southern Mexico, and apparently it has not been found or recognized since.

CHROMOSOME NUMBERS IN THE LIGNEOUS SAXIFRAGACEAE

KARL SAX

Plate 37

The ligneous Saxifragaceae include genera which differ considerably in morphological characters. These differences are so extreme that Hutchinson (1926) has divided this group of plants into three families; the Escalloniaceae, the Grossulariaceae and the Hydrangeaceae. Different genera also vary greatly in the number and distribution of species. Some of them, such as *Carpenteria* and *Whipplea*, are monotypic and endemic in western North America while others, such as *Ribes* and *Hydrangea*, contain numerous species and are widely distributed.

A study of chromosome number was made to determine whether the variability found in this family has a cytological basis and if the number of species in larger genera is associated with polyploidy.

The Arnold Arboretum contains many species of the representative genera of the Saxifragaceae, both American and Asiatic. Most of the chromosome counts were obtained from aceto-carmine smears of pollen mother-cells. The taxonomic grouping is based on Rehder's (1926) Manual.

The following table shows the chromosome numbers, number of species and distribution of the genera studied.

Saxifragaceae

Genus	Chromosome number	Number of Species	Habitat
Philadelphus	13	40	N. America, Asia, Europe
Fendlera Wrightii	11	3	N. America
Jamesia	16	3	Western N. America
Deutzia	13–65	50	Asia, N. America
Decumaria	14	2	Asia, N. America
Hydrangea	18–36	35	Asia, N. & S. America
Schizophragma	14	3	Asia
Itea	11	11	Asia, N. America
Ribes	8	150	N. Hemisphere, S. America

The genus *Philadelphus* is well represented by both American and Asiatic forms. Bangham (1929) obtained chromosome counts of 9 American species, 12 Asiatic species and a number of hybrids and varieties. In all cases the haploid chromosome number was found to be 13. In the hybrids studies there was no indication of any chromosome irregularity. Two of the hybrids investigated were between species which are natives of different parts of the world. These species, or their ancestors, were probably separated

Chromosome numbers in Saxifragaceae

long before the Glacial Period and yet their chromosomes are so similar that there is complete pairing of chromosomes. Species hybrids are very common in this genus wherever different species are brought together in gardens, and it is quite possible that all of the species of the genus can be inter-crossed freely.

The three species of *Fendlera* are found distributed from Colorado to New Mexico. *Fendlera Wrightii* is the only species represented in the Arboretum and it has 11 pairs of chromosomes.

Jamesia is found only in western North America and contains 3 closely related species, only one of which is described by Rehder. The haploid chromosome number of *J. americana* is 16.

Most of the 50 or more species of *Deutzia* are natives of Asia, but two species representing a distinct section (*Neodeutzia*) are found in Mexico. The chromosome numbers of representative species and hybrids are given in Table II. The basic chromosome number is 13 for this genus, but many species are polyploids. The chromosome numbers seem to be closely correlated with taxonomic grouping in some cases. *Deutzia Schneideriana* and *D. scabra* are morphologically similar and both species have 65 pairs of chromosomes. *D. discolor, reflexa* and *Vilmorinae* constitute another group of similar species, each with 52 pairs of chromosomes. *D. mollis* with about 39 pairs of chromosomes is a very distinct species, and other species with the basic chromosome number 13, may vary considerably in taxonomic characters. An interesting case of autopolyploidy is found in *D. parviflora* where the variety *ovatifolia* has 39 instead of 13 chromosomes. This hexaploid variety differs only slightly from the diploid form. The hexaploid variety is perhaps somewhat later in time of flowering, but the two forms are not growing under comparable conditions in the Arboretum. In general the species with the higher chromosome numbers are much later in time of flowering and have thicker stems and more fleshy receptacles than the diploid forms. The pollen grains of the polyploid species are somewhat larger than those of diploids but the difference is not proportional to the differences in chromosome number. All of the species studied produce good pollen with the exception of *D. mollis* where about 10 per cent of the pollen grains are obviously aborted. The chromosomes of the polyploid species usually form only bivalents at meiosis due presumably to the low frequency of chiasma formation between homologous chromosomes.

Among the species hybrids in the genus only one, *D. candelabrum*, was found to be fertile. The others listed in Table II are highly or completely sterile as indicated by the condition of the pollen.

In the unbalanced polyploid species there is of course considerable chromosome irregularity but in some of the sterile hybrids between 13 chromosome species the chromosomes usually pair and divide with little or no irregularity, but a large proportion of the pollen grains do not develop completely. In the two unbalanced polyploid hybrids there is a tendency for trivalents to be formed so that the total number of paired chromosomes is usually less than that of the parent with the larger number.

Table II.

Species of Deutzia	Chromosome number
Sect. I.	
1. D. gracilis	13[1]
2. D. scabra	65[1]
3. D. Schneideriana	65
4. D. Sieboldiana	13
5. D. purpurascens	13?
6. D. discolor	52
7. D. reflexa	52
8. D. Vilmorinae	52
Sect. II.	
9. D. mollis	39
10. D. parviflora	13
11. D. parviflora ovatifolia	39
12. D. hypoglauca	13
Hybrids.	
13. D. candelabrum (1 × 4)	13
14. D. rosea (1 × 5)	13
15. D. magnifica (2 × 8)	$52_{II} + 13_{I}$
16. D. Wilsonii (S) (6 × 9)	42 − 44
17. D. Lemoinei (10 × 1)	13
18. D. candida (17 × 4)	13
19. D. maliflora (17 × 5)	13
20. D. Kalmiaeflora (5 × 10)	13

Decumaria is a small genus with only two species, one in southeastern United States and the other in China. The chromosome number of the American form, *D. barbara*, is 14.

There are about 35 species of *Hydrangea* distributed in North and South America and in Asia. Few natural hybrids are found in this group. The haploid chromosome number is 18 for the American species, *H. cinerea*, *H. quercifolia*, *H. arborescens*, and *H. radiata*. Of the three Asiatic species studied two, *H. Xanthoneura* and *H. petiolaris*, are diploid forms with 18 pairs of chromosomes, while the other, *H. paniculata praecox*, is a tetraploid with 36 chromosomes. According to the recent work of Schoennagel, *H. arborescens*, *aspera*, and *radiata* all have 36 somatic chromosomes.

[1] Recently reported by Schoennagel (1931).

There are 3 species of *Schizophragma*, all of Asiatic origin. The chromosome number of *S. hydrangeoides* is 14, the same as that found in *Decumaria*.

Itea is the only genus of Escalloniaceae available for study in the Arboretum. This genus is represented by about 10 species in Asia and one in southeastern United States. The American species *I. virginiana* has 11 pairs of chromosomes as reported by Schoennagel (1931).

Ribes has been separated into a third family, the Grossulariaceae (Hutchinson). This genus contains about 150 species widely distributed in the northern hemisphere and in South America. Meurman (1928) has found only 8 pairs of chromosomes in this genus although about 20 species were studied. The same counts were also obtained by Tischler (1927) and by Darlington (1927). Mr. Dermen of this laboratory found 8 pairs of chromosomes in each of the following species: *R. Giraldii*, *R. Grossularia*, *R. missouriense*, *R. cynosbati*, and *R. fasciculatum*. In certain species hybrids Meurman finds more or less irregularity in pairing which would indicate that there may be a genetic differentiation of chromosome sets in certain species. In many species hybrids, however, there is normal chromosome pairing at meiosis.

DISCUSSION

The chromosome numbers found in the Saxifragaceae are not closely correlated with the taxonomic grouping. In the Hydrangeaceae, where the genera seem to constitute a natural group, the basic chromosome numbers are 11 in *Fendlera*, 13 in *Philadelphus* and *Deutzia*, 14 in *Decumaria* and *Schizophragma*, 16 in *Jamesia*, and 18 in *Hydrangea*. This variation in chromosome number does not necessarily mean, however, that these genera have not had a common origin because a single genus may include species with different chromosome numbers. In fact the species of the genus *Saxifraga* have 11, 14, 16 or 28 chromosomes (Schoennagel 1931).

Both the taxonomic and cytological evidence indicate that *Philadelphus* and *Deutzia* are closely related as are *Decumaria* and *Schizophragma*, but *Fendlera* and *Itea* with the same chromosome numbers differ considerably in morphological characters.

Pollen grain measurements do not show much difference for the various genera, with the exception of *Ribes*. The pollen grains of *Ribes* are more than twice as large as those of the other genera, which may be some indication that this genus forms a rather distinct group of plants. (Hutchinson 1926).

In this family there are two large genera which show no variation

in chromosome number of the various species. There are about 40 species of *Philadelphus* and all of the species studied have 13 pairs of chromosomes. A considerable number of the 150 or more species of *Ribes* have been examined (Meurman, Tischler, and Darlington) and all have 8 pairs of chromosomes. In both genera species hybrids are numerous. In many of these species hybrids the chromosomes pair at meiosis and in some there is a high degree of fertility.

The species of *Philadelphus* are morphologically very similar, even though they are widely distributed. Of the species enumerated by Rehder 7 are found in China, 2 in Manchuria and Korea, 1 in Japan, 2 in the Himalayas, 1 in southeastern Europe, 5 along the west coast of North America, 6 in central and southeastern United States, and 3 in Colorado and New Mexico.

All of these species undoubtedly had a common origin. Species hybrids are numerous in this genus and it is probable that all species of *Philadelphus* will intercross freely. Hybrids have been obtained between such widely separated species as *P. pubescens*, a native of southern United States, and *P. tomentosus*, a native of the Himalayas; or between *P. pubescens* and the Pacific coast species *P. Gordonianus;* or between *P. laxus* of Georgia and *P. coronarius* of Europe. In certain species hybrids such as *P. pendulifolius*, which is supposed to be a cross between *P. pubescens* of Tennessee and Alabama and *P. laxus* of Georgia, the F_1 is highly fertile and the pollen grains are normal. In the hybrid *P. Lemoinei* a cross between American and European species, the chromosomes pair and the divisions are normal but most of the pollen grains do not mature. The female gametes must be functional, however, because this hybrid has produced numerous varieties when crossed with other species. In the hybrid, *P. maximus*, a cross between a Himalayan and an American species, the microspores disintegrate at an early stage and the plant is highly sterile.

Meurman (1923) finds a similar condition in *Ribes*. Closely related species from the same continent produce more or less fertile hybrids with normal chromosome pairing at meiosis. Hybrids between species from different continents were found to be highly sterile with various degrees of chromosome pairing.

Some of the species of *Philadelphus* and *Ribes* can apparently retain their identity only so long as they are isolated. In the course of species formation in these genera mutations must have occurred with geographic isolation. At the present time some of the species probably do not differ greatly in genetic constitution while others are so highly differentiated that fertile hybrids can no longer be

obtained between certain species. In *Philadelphus*, at least, the species are not sufficiently different to prevent crossing between most or perhaps all species of the genus. In view of the genetic and cytological analysis of these genera it would seem that the same factors which have produced varietal differences are responsible for species and in certain cases even generic differentiation (i. e. *Philadelphus* and *Deutzia*). Mutation seems to have been the basic factor in causing variation in *Philadelphus* and *Ribes* although it is possible that changes have occurred in chromosome structure.

It has often been assumed that the individuals within a species can cross freely with a high degree of fertility, while crosses between species result in partially or completely sterile hybrids (Babcock 1931). The fact that two individuals are inter-sterile does not necessarily mean that they belong to different species. Genetic factors, changes in chromosome structure, or autopolyploidy may be responsible for a high degree of sterility in varietal hybrids. On the other hand plants, which would be classed by the most conservative taxonomists as distinct species, are often interfertile. According to the species concept based on cyto-genetics some polymorphic genera would be reduced to a single species, while the number of species in other genera would be greatly reduced. Such a concept of a species seems hardly justified from the point of view of the taxonomist. However, the taxonomic status of certain genera, such as *Crataegus*, would be greatly improved if the taxonomist were required to make the cyto-genetic tests before naming a new species!

Perhaps it would be more practical to apply the cyto-genetic test to fundamental or basic species. These "basic species" would include all individuals which have similar genoms and which produce fertile hybrids. Even the cyto-genetic tests cannot draw precise lines between basic species because of various degrees of chromosome pairing and sterility in species hybrids. It is of interest to note that there is complete chromosome pairing in many species hybrids in *Philadelphus* and in *Deutzia*, but there is a high degree of pollen sterility in these hybrids.

Deutzia and *Philadelphus* are closely related and both have the same basic chromosome number, but one genus is uniform in chromosome number while the other contains a series of polyploid species. Why should *Philadelphus* be so uniform and *Deutzia* so variable in the chromosome number of different species? Polyploidy may be induced by genetic factors, by environmental conditions, and is probably dependent to some extent on the number

of chiasmata which unite the homologous chromosomes at meiosis.

In both *Philadelphus* and *Deutzia* there is apparently insufficient differentiation of chromosomes to prevent pairing of chromosomes in species hybrids. There is, however, a greater amount of morphological differentiation of the *Deutzia* species, even among those with the basic chromosome number. In certain species hybrids the chromosomes may fail to pair or are so loosely associated that environmental conditions would easily inhibit pairing. In such hybrids diploid gametes would be expected occasionally which would give rise to fertile intermediate polyploid species. Such types of new species have been produced in a number of genera (Clausen and Goodspeed 1925, Karpenchenko 1927, et al.) and recently Muntzing (1931) has been able to synthesize a widespread tetraploid Linnean species. It is possible that some of the polyploid *Deutzias* have been produced in this way.

Variations in temperature may also cause a semi-heterotypic division at meiosis and cause the production of tetraploid varieties. These tetraploids, since they are partially sterile when crossed with the diploid forms would serve as a basis for the development of new species by mutation even without geographic isolation. As Belling (1925) has suggested, the tropical or subtropical species might be more susceptible to the influence of low temperatures. In general, the species of *Deutzia* have a more southern range, are less hardy, and bloom earlier than the species of *Philadelphus*. The fact that the autopolyploid variety of *D. parviflora* is a hexaploid indicates that polyploidy has been due, in part at least, to the production of diploid gametes.

In both *Philadelphus* and *Deutzia*, and in the other genera of Saxifragaceae, the chromosomes at the first meiotic division are usually united by a single terminal or sub-terminal chiasma. There is apparently no difference in the chromosome pairing which would favor the production of diploid gametes in *Deutzia*.

Polyploidy in *Deutzia* may be due to greater differentiation of the chromosomes in different species and to the production of diploid gametes induced by low temperatures, facilitated perhaps by the low frequency of chiasma formation between homologous chromosomes at meiosis.

SUMMARY

The basic chromosome numbers of representative genera of the ligneous Saxifragaceae were found to be 13 in *Philadelphus* and *Deutzia*, 16 in *Jamesia*, 14 in *Decumaria* and *Schizophragma*, 18 in *Hydrangea*, 11 in *Fendlera* and *Itea*, and 8 in *Ribes*.

Deutzia contains many polyploid species, with numbers as high as 65 pairs of chromosomes, while the closely related genus *Philadelphus* contains only diploid species. The possible causes of these differences are discussed.

In both *Deutzia* and *Philadelphus* the chromosomes may pair in species hybrids and apparently normal microspores are produced, but the pollen is highly sterile in most of these hybrids.

Most, or perhaps all of the species of *Philadelphus* can be intercrossed freely and some of the hybrids are at least partially fertile. Species hybrids are also frequently found in *Deutzia* and in *Ribes*. Some of these species are apparently maintained as distinct units only by geographic isolation. The species concept is discussed in relation to the cyto-genetic analysis of certain genera.

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DESCRIPTION OF PLATE 37

Chromosome numbers in Saxifragaceae. Drawing from aceto-carmine smears of pollen mother cells. × 2100. (M. = metaphase).

Fig. 1. *Philadelphus Schrenkii*.....I M.
Fig. 2. *Fendlera Wrightii*.....I M.
Fig. 3. *Jamesia americana*.....1st tel.
Fig. 4. *Deutzia Lemoinei*.....II M.
Fig. 5. *D. rosea campanulata*.....I M.
Fig. 6. *D. parviflora ovatifolia*.....I M.

Fig. 7. *D. Vilmorinae*.....I M.
Fig. 8. *D. scabra*.....I M.
Fig. 9. *Decumaria barbara*.....I M.
Fig. 10. *Hydrangea Xanthoneura*.....I M.
Fig. 11. *H. quercifolia*.....I M.
Fig. 12. *Schizophragma hydrangeoides*....I M.
Fig. 13. *Itea virginiana*.....I M.
Fig. 14. *Ribes grossularia*.....I M.

POLYPLOIDY IN THE BETULACEAE

ROBERT H. WOODWORTH

The family Betulaceae contains six genera with more than one hundred species in the temperate and colder regions of the northern hemisphere. Hutchinson (1926) considers the Betulaceae to consist of but two genera, *Betula* and *Alnus*. He places the other four genera, *Carpinus*, *Ostrya*, *Ostryopsis*, and *Corylus* in a new family, the Corylaceae. Over sixty species of these six genera are growing in the Arnold Arboretum, each genus being well represented.

Betula is the best known and the largest genus containing some forty species which grow exclusively in the northern regions. From their circumpolar range they radiate out into Europe, Asia and North America in numbers of parallel forms which fall into somewhat definite geographic entities. They are baffling in their variability and accordingly very difficult to classify. Even though there were four times as many extinct species of *Betula* as there are existing species, the genus came through the glacial periods remarkably well as compared with most genera.

The species and varieties of *Betula* have interesting chromosome numbers. Many have fourteen pairs, four have twenty-eight pairs, two have thirty-five pairs, and three have forty-two pairs of chromosomes. About thirty of the forty known species are growing in the Arnold Arboretum. The specific names used are those found in Rehder's Manual (1927).

The existing species apparently form natural hybrids readily, since fifteen crosses have already been described by taxonomists. Four natural hybrids between species of different chromosome numbers have proved interesting from the cytological standpoint (Woodworth, 1929–1930). *Betula Jackii* is the result of a natural cross between *B. lenta* with fourteen gametic chromosomes and *B. pumila* with twenty-eight gametic chromosomes. Helms and Jorgensen (1925) report a similar European hybrid which is readily formed in nature from *B. verrucosa* with fourteen gametic chromosomes and *B. pubescens* with twenty-eight gametic chromosomes.

In both of the above hybrids there are fourteen pairs and fourteen univalent chromosomes at the metaphase of the reduction division.

B. Sandbergi was discovered in the tamarack swamps of southern Minnesota. Since then it has been found that true *B. pumila* does not occur west of New York State and that the plants which had been called *B. pumila* are really F_2 segregates of *B. Sandbergi* (Rosendahl, 1928). *B. papyrifera* with thirty-five gametic chromosomes and *B. pumila* var. *glandulifera* with twenty-eight gametic chromosomes are the parents of *B. Sandbergi* which has sixty-three chromosomes in the sporophytic tissue. The reduction division usually shows twenty-eight pairs and seven single chromosomes some of which may pair among themselves.

B. Purpusii from the taxonomic evidence is clearly a hybrid between *B. lutea* and *B. pumila* var. *glandulifera*. The former parent has forty-two pairs of chromosomes and the latter parent has twenty-eight. The cytology of the hybrid shows about twenty-eight pairs of chromosomes at the metaphase of the reduction division and about fourteen single chromosomes distributed all along the spindle. The metaphase plates of the sporophytic cells have seventy chromosomes. This plant also grows in the tamarack swamps of Minnesota.

The polymorphism of *B. papyrifera* and its varieties is well known to the systematist. *B. papyrifera* and its variety *kenaica* both have thirty-five pairs of chromosomes. *B. papyrifera* var. *cordifolia* and *B. papyrifera* var. *subcordata* both have twenty-eight pairs of chromosomes. *B. papyrifera* var. *occidentalis* has forty-two pairs of chromosomes.

B. japonica has fourteen pairs of chromosomes. *B. japonica* var. *mandshurica* has at the reduction division fourteen pairs and twenty-eight single chromosomes which behave abnormally. This variety appears to be a natural hybrid between *B. japonica* and some species with forty-two pairs of chromosomes. *B. grossa* grows in the same regions as *B. japonica* and its variety, and has forty-two pairs of chromosomes.

BETULA

Section	Species	Chromosome Number (pairs)	Native Habitat
Eubetula			
Subsection			
Costatae	B. nigra	14	E. U. S.
	B. utilis var. Prattii	14	W. China
	B. Schmidtii	14	N. E. Asia
	B. lenta	14	E. U. S.
	B. lutea	42	E. N. Am.
	B. grossa	42	Japan

Nanae	B. pumila	28	N. E. N. Am.
	B. pumila var. glandulifera	28	N. E. N. Am.
Albae	B. populifolia	14	E. N. Am.
	B. coerulea-grandis	14	N. E. N. Am.
	B. fontinalis var. Piperi	14	N. W. U. S.
	B. pendula	14	S. Eurasia
	B. japonica	14	N. E. Asia & Japan
	B. pubescens	28	N. Eurasia
	B. papyrifera var. cordifolia	28	N. E. N. Am.
	B. papyrifera var. subcordata	28	W. N. Am.
	B. papyrifera	35	N. N. Am.
	B. papyrifera var. kenaica	35	Alaska
	B. papyrifera var. occidentalis	42	W. N. Am.
	B. davurica	about 45	N. E. Asia & Japan
Betulaster Subsection Acuminatae	B. Maximowicziana	14	Japan

Natural Hybrids	Sporophytic & Parental Chromosome Numbers	Native Habitat
B. coerulea (coerulea-grandis × populifolia)	28 (14 + 14)	N. E. N. Am.
B. Jackii (lenta × pumila)	42 (14 + 28)	Mass.
B. verrucosa × pubescens	42 (14 + 28)	N. Europe
B. Sandbergi (pumila var. glandulifera × papyrifera)	63 (28 + 35)	N. U. S.
B. Purpusii (pumila var. glandulifera × lutea)	70 (28 + 42)	N. U. S.
B. japonica var. mandshurica (japonica ×?)	56 (14 + 42)	N. E. Asia

Alnus consists of about thirty species. It is the only member of the family that extends its range into the southern hemisphere and here only in the highlands of the Andes as far south as Peru. The Alders differ from the Birches mainly in their persistent and woody seed bearing cones. Some twelve species are growing in the Arnold Arboretum. The following species have fourteen pairs of chromosomes: *A. incana*, *A. crispa* var. *mollis*, *A. maritima;* while *A. japonica*, *A. Spaethii* and *A. glutinosa* all have twenty-eight pairs of chromosomes. The New England *A. rugosa* is something of a puzzle cytologically. Some of the plants have extremely irregular reduction divisions which strongly suggest a hybrid origin (Woodworth, 1929). Material from all the other species was collected at the same time and treated in exactly the same manner. That the abnormalities were not caused by the fixing fluid or any external agent is clearly shown by the presence

of dwarf pollen grains and almost complete sterility of the contents of the anthers. When the divisions of the spore mother cells of *A. rugosa* are at all normal they have fourteen pairs of chromosomes. At other times it seems that some of the chromosomes have fragmented or that the other parent had about twenty-eight chromosomes. Although cytological material of *A. rugosa* from the southeastern United States has not yet been available for study, some of the mature catkins have been procured from Virginia and these have almost perfect pollen. This suggests that the polymorphism and cytological irregularities of the New England *A. rugosa* is probably due to the formation of natural hybrids between *A. incana* and *A. rugosa* where the two species grow together. Experiments are now being carried out along this line in an attempt to produce hybrid *A. rugosa.*

A. Spaethii has been reported as a hybrid between *A. subcordata* and *A. japonica. A. Spaethii* has regular meioses with twenty-eight pairs of chromosomes. *A. japonica* growing in the Arnold Arboretum also has twenty-eight pairs. Catkins of *A. subcordata* have not been available to me for study but Wetzel (1929) reports fourteen pairs of chromosomes for this species and also for *A. japonica.* If *A. Spaethii* is a hybrid its parents must have been either fourteen chromosome or twenty-eight chromosome individuals. If they had fourteen chromosomes there is no homology between any of the members of the chromosome sets, and if the parents had twenty-eight chromosomes there is complete homology between the chromosome sets. I believe that the hybrid nature of *A. Spaethii* is open to question.

There are fifteen species of *Corylus.* The Hazels are well known as ornamental trees and shrubs but perhaps better for their edible nuts (filberts and hazelnuts). The eleven species, five varieties and one hybrid growing in the Arnold Arboretum all have fourteen pairs of chromosomes. They are: *C. americana, C. americana* × *pontica, C. Avellana, C. Avellana* var. *pendula, C. Avellana* var. *pontica, C. colurna, C. cornuta, C. heterophylla, C. heterophylla* var. *sutchuenensis, C. maxima, C. maxima* var. *purpurea, C. Sieboldiana, C. Sieboldiana* var. *mandshurica, C. tibetica, C. spinescens, C. Vilmorinii, C. no. 9 of Vollertsen.* Wetzel (1929) reports the haploid number to be eleven in *C. Avellana, C. maxima* and *C. mandshurica.*

Species	Chromosome Number (pairs)	Native Habitat
Alnus incana	14	N. E. N. Am., Eur.
A. rugosa	14	E. N. Am.
A. crispa var. mollis	14	N. E. N. Am.

Species	Chromosome Number (pairs)	Native Habitat
A. maritima	14	E. N. Am.
A. japonica	14[1], 28	Japan, N. E. Asia
A. Spaethii	28	unknown
A. glutinosa	28	Eurasia, N. Afr.
A. subcordata	14[1]	Asia
Carpinus caroliniana	8	E. N. Am.
C. laxiflora	8	China
C. orientalis	8	S. E. Eur., Asia Minor
C. Turczaninovii	8	China, Korea
C. japonica	8	Japan
C. cordata	8	Asia
C. betulus	8	Eurasia
C. betulus var. fastigiata	32	
Ostrya virginiana	8	E. N. Am.
O. virginiana var. glandulosa	8	N. E. N. Am.
O. carpinifolia	8	S. Eur., Asia Minor
O. japonica	8	Asia
Ostryopsis Davidiana	8	China
Corylus (all species)	14	N. Am., Eur., Asia

[1] Wetzel, 1929.

There are about twenty species of *Carpinus*. The Hornbeams are known for their handsome foliage and their extremely hard and tough wood. It is noteworthy that the species have eight pairs of chromosomes which is in marked contrast to the species of the three genera treated above, which have fourteen as the fundamental number. *C. betulus* var. *fastigiata* deserves special mention since it has thirty-two pairs of chromosomes while *C. betulus*, *C. caroliniana*, *C. laxiflora*, *C. Turczaninovii*, *C. orientalis*, *C. japonica*, *C. cordata* all have eight pairs.

There are seven species of *Ostrya*, the Hop-hornbeam. Mature plants of *O. virginiana*, *O. virginiana* var. *glandulosa*, *O. carpinifolia*, *O. japonica* are growing in the arboretum. They all, like *Carpinus*, have eight pairs of chromosomes.

Ostryopsis has but two species. One, *O. Davidiana*, is growing in the Arnold Arboretum. It has eight pairs of chromosomes.

The chromosomes at the reduction division in the Betulaceae are almost spherical and small. The species of *Betula*, *Alnus*, *Carpinus*, *Ostrya*, and *Ostryopsis* have chromosomes which measure approximately one micron in diameter. The notable exceptions to this measurement are those species of *Betula* which have large numbers of chromosomes. The three plants with forty-two gametic chromosomes show these bodies to have a diameter of .6 of one micron, while those species with the intermediate chromosome numbers show, in general, an intermediate chromosome diameter. In the above genera the size of the pollen mother cells

and the pollen grains increases as the chromosome number increases.

The chromosomes of the various species and varieties of *Corylus* are very small. They average approximately 0.5 of one micron in diameter. Compared with diploid species of the other genera they are half size. Nevertheless the pollen mother cells and the pollen grains are as large as those of any species in the family.

It has frequently been found that the species of certain subgenera or subsections will readily hybridize among themselves but not with the species of other subgenera or subsections, while in other groups there is free crossing between diverse species or even between genera. In recently suggested definitions of a species free intercrossing and high interfertility among the individuals of the group and absence of free intercrossing and low fertility or complete sterility in interspecific hybrids are considered important for the genetic bearing on the species concept (Muntzing, Tedin and Turesson, 1931; Babcock, 1931; Sax, 1931). In *Betula* the data above show that *B. pumila*, representing the dwarf Birches, readily hybridizes with species of both other subsections. Furthermore, it has recently been found that the plants from Michigan, Wisconsin, Minnesota, and Indiana which have long been called *B. pumila* are in reality F_2 segregates of $\times$ *B. Sandbergi* and that true *B. pumila* does not occur west of New York State (Rosendahl, 1928). Since *B. lenta* and *B. pumila* var. *glandulifera* are quite distinct species the hybrid *B. Sandbergi* is an exception to the genetic part of the specific concept noted just above. Experiments discussed below show the Betula species to hybridize readily.

EXPERIMENTAL HYBRIDS

The following experiments in crossing birch species have proved successful to the extent that embryos were formed. In each case twelve seeds were cut open and examined. The seeds of a great many more crosses than these have been planted but only in those listed here have embryos been seen. The gametophytic chromosome number of each parent is given.

B. pendula (14) produced seeds with embryos when crossed with: *B. coerulea-grandis* (14), *B. pumila* (28), *B. papyrifera* var. *cordifolia* (28), *B. grossa* (42).

B. Maximowicziana (14) crossed with *B. lutea* (42) and *B. davurica* (about 45).

B. pumila (28) crossed with *B. lenta* (14), *B. nigra* (14), *B. japonica* (14), *B. Maximowicziana* (14), and *B. papyrifera* var. *cordifolia* (28).

B. papyrifera var. *cordifolia* (28) crossed with *B. pendula* (14), *B. pumila* (28), *B. papyrifera* var. *kenaica* (35), *B. lutea* (42), and *B. papyrifera* var. *occidentalis* (42).

B. papyrifera var. *kenaica* (35) crossed with *B. papyrifera* var. *occidentalis* (42).

B. lutea (42) crossed with *B. lenta* (14), *B. coerulea-grandis* (14), *B. pumila* (28), *B. grossa* (42), and *B. papyrifera* var. *occidentalis* (42).

B. papyrifera var. *occidentalis* (42) crossed with *B. lenta* (14), *B. pendula* (14), *B. pumila* (28), *B. papyrifera* (35) and *B. papyrifera* var. *kenaica* (35).

B. davurica (about 45) crossed with *B. pendula* (14), *B. Maximowicziana* (14), *B. papyrifera* (35), *B. lutea* (42), and *B. japonica* var. *mandshurica* (42).

If all of these crosses which are known to have formed seeds with embryos should produce viable plants, hybrids with the following sporophytic chromosome numbers would be formed: one diploid (28), seven triploids (42), nine tetraploids (56), four pentaploids (70), one octoploid (84), and these dysploids; one 49, three 59's, one 63, one 77, one 80, and two 87's.

Since these seeds have not yet germinated it may be a little early to anticipate results, but it does seem as though the species of *Betula* are highly interfertile.

DISCUSSION

Species formation is probably due to changes in chromosome structure and chromosome number. Some genera consist of species all of which have the same chromosome number. Species formation in such groups might be attributed to gene mutations and other structural changes within the individual chromosomes aided perhaps by hybrids between varieties. Other genera consist of species which have different chromosome numbers. Species formation in these groups might be due not only to the causes mentioned above but also to the duplication of chromosomes or chromosome sets and to the combination of chromosome sets from different species.

Recent points of view hold that mutations are the basic cause of variation and evolution and that evolution is speeded up and aided by first varietal and later species hybridization (Wright, 1931 and others).

Many interesting polyploid series have been investigated. Considerable evidence supports the view that plants with the higher chromosome numbers have originated from those species with the smaller chromosome complement. A useful distinction has been

made amongst polyploids (Kihara & Ono, 1926) according as their gametic complements are built up by the reduplication of similar series (autopolyploidy), that is, by the doubling of the chromosome number in a theoretically pure line, or by the combination of dissimilar series (allopolyploidy), that is, by doubling in a hybrid. There is not complete agreement as to which of these types of polyploid formation is the more frequent in nature. Jorgensen (1928) considers that hybridization has played a much greater role in the improvement of our cultivated plants than it has in species formation; that species hybridization occurs but rarely in nature; and that tetraploidy induced in the sparse species hybrids found in nature is very rare in comparison with the tetraploidy found in the huge numbers of pure species. Darlington (1927 and 1928) on the other hand concludes that polyploids have often arisen as the result of hybridization between diploid species and that most normally seed producing polyploids occurring in nature fall in the allopolyploid group.

Species of *Ostrya*, *Ostryopsis* and *Carpinus* all have eight as the basic chromosome number while species of *Betula*, *Alnus* and *Corylus* have the basic number of fourteen. Hutchinson (1926) has placed *Betula* and *Alnus* in the Betulaceae and has proposed another family, the Corylaceae, for *Corylus*, *Carpinus*, *Ostrya* and *Ostryopsis*. From the standpoint of chromosome number *Corylus* should go in with *Betula* and *Alnus*. Furthermore, *Corylus* species form their staminate catkins and mature their pollen in the fall as do the species of *Betula* and *Alnus* (except *A. maritima*) while the members of the other genera form and mature their pollen just previous to its shedding in the spring. If the family is to be split into two families a more natural grouping from the developmental and cytological evidence would place *Corylus* in with *Betula* and *Alnus*.

The basic chromosome number in this family is apparently seven, although no member has yet been found to have seven pairs of chromosomes. The eight chromosome genera may have originated from an original seven chromosome strain by the duplication of one chromosome. The fourteen chromosome genera would then have come about by a duplication of the original set of seven chromosomes. The meiotic conditions in *Corylus* may be of significance here. Wetzel (1929) reports eleven pairs of chromosomes in *C. Avellana*, *C. maxima* and *C. mandshurica*. During the reduction division in all species listed above there is an affinity between some of the gemini to the extent that usually two and sometimes three pairs of bivalents fuse to form tetrasomes, thus

often causing the haploid number to be less than fourteen (Woodworth, 1929). If this be a normal process it may indicate an affinity of homologous chromosome pairs which in turn suggests a doubling, if not of a whole chromosome set, at least of certain chromosomes. However, Yarnell (1929) has shown that we can not be too dogmatic about the idea that only homologous chromosomes pair. In an artificially produced triploid *Fragaria* he has found unmistakable pairing between non-homologous chromosomes. This also happens in *Betula Sandbergi*.

Species formation in the genus *Corylus*, since all species have fourteen chromosome pairs, might be attributed to gene mutations and other structural changes within the individual chromosomes aided perhaps by hybrids between varieties, although it has recently been suggested that gene mutations have little influence in species formation (Anderson, 1928).

Species of *Alnus* seem to be well defined, with the exception of the New England material of *A. incana* and *A. rugosa*. The existence of much intergrading material makes for obscurity in specific lines. Much of the *A. rugosa* material has very abnormal meioses in both microgametophyte and macrogametophyte and the abundance of viable seed has been found to develop apogamously and to be polyembryonic (Woodworth, 1930). There is then here a correlation between polymorphism and reproductive irregularities. Some specimens of *A. japonica* have been reported as having fourteen pairs of chromosomes while others have twenty-eight pairs. Since the plants are taxonomically *A. japonica* there is no doubt that there has been a duplication of the chromosome set (autopolyploidy).

Carpinus betulus has eight pairs of chromosomes, while its variety *fastigiata* has thirty-two pairs. This variety obviously belongs to *C. betulus* because it differs only in its narrow pyramidal habit. The octoploid chromosome number probably originated in a four fold reduplication of the eight pairs of chromosomes (autopolyploid).

It has been mentioned above that *Betula* species are very difficult taxonomically. This is due to many intergrading forms. Fernald (1902) has shown that it is possible to trace by a series of specimens a direct connection between dwarf *B. nana*, through variants of many other species, to the tall *B. alba*. He notes that since it is obviously impracticable to regard all these forms as one species, it seems wise to recognize the more marked centers of variation as species which are admitted to pass by exceptional tendencies to other forms ordinarily distinguished by marked characteristics.

Evidence already discussed above and a careful study of hybrid birches of northern Europe support the thesis that some of this polymorphism at least is due to hybridization (Helms & Jorgensen, 1925). One of the well known authorities on the taxonomy of the Betulaceae has recently pointed out that hybridism in the genus *Betula* has played a very important rôle and is directly responsible for much of the variation so troublesome to specific concepts (Winkler, 1930).

Species of *Betula* show considerable polyploidy. The Betula list shows nine diploids, two triploids, four tetraploids, two pentaploids, three hexaploids. Here we have polymorphism and polyploidy occurring together. A mechanism for the origin of polyploidy is seen in × *B. Jackii*, × *B. Sandbergi*, × *B. Purpusii*, *B. japonica* var. *mandshurica*, *B. papyrifera* var. *cordifolia*, and *B. davurica*. In the anther sacs of these plants diads of diploid pollen grains are formed by the failure of one of the meiotic divisions (Woodworth, 1929–1930). Some even form tetraploid gametes. Most of these forms, and probably all of them, are definitely cases of allopolyploidy and they are now producing polyploid gametophytic tissue which, if it functions in fertilization, may be the basis for more polyploid or aneuploid forms.

The meioses of the tetraploid, pentaploid and hexaploid species, such as *B. pumila*, *B. papyrifera* and *B. lutea*, respectively, show a high percentage of chromosome pairing but frequently there are a few chromosomes which remain univalent. Slight irregularities lead to occasional formation of microcytes but I have never seen any diads of diploid pollen grains in any of the well marked diploid or polyploid species. Nor has an examination of thousands of mature pollen grains of these species disclosed any large grains which might be diploid in content. A high percentage of chromosome pairing would indicate duplication of similar sets of chromosomes or autopolyploidy. Experiments now being carried in crossing many of these birches may throw some light on their true origin.

B. papyrifera and its varieties constitute an interesting polyploid group. *B. papyrifera* var. *cordifolia* and *B. papyrifera* var. *subcordata* have twenty-eight gametophytic chromosomes, *B. papyrifera* and *B. papyrifera* var. *kenaica* have thirty-five, and *B. papyrifera* var. *occidentalis* has forty-two. The taxonomy of these plants is not yet well established. All of these varieties were previously considered to be distinct species. Recently Professor Rosendahl in correspondence has noted that var. *cordifolia* in northern Minnesota is quite distinct in many characteristics from *B. papyrifera*.

The chromosome numbers offer some support to this view although there are some fifty species of plants which are known to contain individuals with different chromosome numbers and complexes (Clausen, 1931). The formation of polyploid gametes is characteristic of hybrids. Since *B. papyrifera* var. *cordifolia* forms diads of diploid pollen grains it may have had a hybrid origin and if so it is allopolyploid. At the present time it is difficult to decide whether *B. papyrifera* and its varieties are to be considered autopolyploid or allopolyploid. In cases of this sort, taxonomy, cytology, genetics, and phytogeography must contribute in order that conclusions may be of value. Experiments in crossing individuals of this species and its varieties are being made with the hope that the interspecific hybrids will prove valuable toward clarifying the nature of the group.

The fact that none of the diploid species are now seen to be producing polyploid gametes does not of course preclude the possibility that they may have done so in the past. It is well known that certain groups of plants have passed through periods of great activity in individual variation and species building. The cause of this unusual behavior is not agreed upon by all investigators by any means. If it is internal it may be that polyploidy in *Betula* originated at a time when the group passed through a fluctuating state and it may have been due to cases of pure autopolyploidy.

SUMMARY

Species of *Betula* have the following numbers of chromosome pairs: 14, 28, 35 and 42. Six natural hybrids show significant correlative cytological data. *B. papyrifera* and its varieties have different polyploid chromosome numbers.

Species of *Alnus* have 14 and 28 pairs of chromosomes. The tetraploid species are probably autopolyploid.

Corylus species have 14 pairs of extremely small chromosomes.

Species of *Carpinus*, *Ostrya* and *Ostryopsis* have 8 pairs of chromosomes. *Carpinus betulus* var. *fastigiata* has 32 pairs and is autopolyploid.

Polyploid species have smaller chromosomes, in general, than diploid species (except in *Corylus*).

Thorough examination has disclosed no binucleate archesporial cells, no meioses producing diploid microspores and no unusually large pollen grains in the well marked diploid and polyploid species of the Betulaceae.

The only plants in the family which are known to produce diploid and sometimes tetraploid pollen grains are those which

are known to be or which are suspected of being of heterozygous origin. Polyploidy in *Betula* has been both allopolyploid and autopolyploid.

Experiments in crossing Betula species have proved about 50% effective in embryo formation.

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MILESINA RUSTS ON ASPIDIUM BRAUNII SPENNER

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THE white-spored rusts of Conifers are included in the two genera *Milesina* and *Uredinopsis*. All have their diploid stage on ferns, and for the few of which the complete life cycle is known, their haploid stage on *Abies*. Until quite recently only one white-spored rust was recognized on *Abies* in America, the so-called *Peridermium balsameum* Peck, but we now know that this name stood for a dozen or more species of *Milesina* and *Uredinopsis*. The same situation exists in Europe with regard to *Aecidium pseudocolumnare* J. Kuehn on *Abies*. Sydow remarks (Monographia Uredinearum, 4: 13, 1915) "Aus Klebahn's Versuchen geht jedoch gleichzeitig hervor, dass das weisssporige *Aec. pseudocolumnare* insofern keine einheitliche Art darstellt, als es zu verschiedenen Farn-Uredineen gehört, nämlich zu *Uredinopsis Struthiopteridis* Störm. und *Milesina Blechni* Syd., wahrscheinlich auch noch zu anderen Arten." There now comes to hand a welcome paper by Kamei (Notes on *Milesina vogesiaca* Syd. on *Polystichum Braunii* and its Peridermial Stage on the Needles of *Abies Mayriana, A. firma* and *A. sachalinensis*. Trans. Sapporo Nat. His. Soc. 11: 142–147. 1930) which records a new fern host of a known rust species and untangles a portion of the rust maze on *Abies*, and directly thereafter a new species on the same fern which calls for discrimination and further work on *Abies*.

Kamei's procedure was to culture from the teliospores of the fern rust onto the various species of *Abies* named above, and then from *Abies* back to the fern. He was completely successful with his experiments in both directions. A close morphological examination of the rust involved convinced him that it was *M. vogesiaca* Syd., a rust heretofore known in Europe only and on another, though related, fern host, *Aspidium lobatum*. Since the life history of *M. vogesiaca* in Europe has not yet been worked out and no cross-inoculations made as between *A. lobatum* and *A. Braunii*, Kamei's taxonomic determination, while probably correct, is of tentative status.

Additional interest now accrues to the subject from the discovery of a *Milesina* on *A. Braunii* quite distinct from *M. vogesiaca*. The material was communicated through the courtesy of Director A. Wróblewski of Kórnik, Poland. The description follows:

Milesina exigua, n. sp.

O and I. Spermogonia and aecia unknown.

II. Uredinia hypophyllous, subepidermal, scattered or loosely

grouped on greenish to brownish areas of indefinite extent, pustular, 0.1 to 0.2 mm. in diameter, opening outwards through a centrally placed stomatic pore in the overlying brownish epidermis; peridium hemispheric, hyaline, delicate; peridial cells isodiametrically to irregularly polygonal, 8 to 15 μ across; walls of peridial cells hyaline, 0.5 to 1.0 μ thick; uredospores colorless, smooth, thin-walled (0.5–1 μ), short-stalked, obovate to elliptical or subspherical, 14–17 × 18–31 μ, averaging about 15 × 23 μ.

III. Unknown.

The type material of this species was collected on *Aspidium Braunii* Spenner by Antoine Wróblewski at Kniaździwór, District of Kolomea, Poland in August, 1913. I have also had the opportunity of studying further material on the same host from Olszanica, Lesko, Poland, collected October 18, 1917. It is to be expected that an abundance of telia develops on overwintered fronds in late spring or early summer; and it is almost equally certain that the peridermial stage occurs on *Abies*.

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NOTES

A Silvicultural Study of Abies pinsapo. Under the title "A travers les forêts de Pinsapo d'Andalousie" A. Barbey[1] has published a detailed study of *Abies pinsapo* considering it from a dendrological, silvicultural and entomological point of view. The author is a grandson of Edmond Boissier who in 1837 first recognized and described this Fir as a new species and whose portrait forms the frontispiece of the volume. A brief biography of Boissier is given and his description of *Abies pinsapo* is reprinted and also that part of his "Voyage botanique dans le midi d'Espagne"[2]) which refers to *Abies pinsapo* with reproductions of the two original plates of that Fir and one of *Quercus alpestris* Boiss. In 1929 the author visited the Sierra de Ronda and adjoining mountain ranges in Andalusia to study *Abies pinsapo* from a silvicultural point of view. In this region the forests of Pinsapo are found at an altitude of 1000–1800 m. and cover approximately an area of 1200 hectares. The tree has many enemies and if no protective measures are taken, it may disappear altogether from its native habitat. Natural re-

[1] Barbey, A. À travers les forêts de Pinsapo d'Andalousie; étude de dendrologie, de sylviculture et d'entomologie forestière. Préface de M. L. Pardé. 110 pp. 41 pl. O. Paris & Gembloux, 1931.

[2] A copy of this very rare work by Boissier with 181 (207) hand colored plates is to be found in the Library of the Arnold Arboretum.

generation is prevented or made difficult by grazing animals, such as goats, sheep and cattle; many insects prey on the trees, and drought during the summer is also often injurious. Besides, charcoal burners do much harm by cutting off the branches to a considerable height and formerly the "neveros," men who collected snow for refrigerating purposes, were careless with fire and burned old trees and destroyed young growth when working on the high plateaus, but since artificial ice has chiefly replaced the condensed snow brought from the mountains, the menace of the "neveros" has become negligible. Numerous photographs show stands of Pinsapo in various aspects, the young trees often mutilated and deformed by goats and sheep. There are also pictures of fine trees in cultivation in different countries of Europe where it has been planted as an ornamental tree and even has given rise to a number of interesting garden forms. There will perhaps soon be more and finer specimens of this tree in gardens and parks outside of Spain than in its original habitat, if immediate measures are not taken for its protection. To the insects preying on the Pinsapo the author who is an authority on forest entomology has paid special attention and enumerates a considerable number of species chiefly Coleoptera and describes and figures them and their ravages. There is also a brief chapter dealing with the insects of *Quercus alpestris* which is associated in the Sierra de Ronda with the Pinsapo and of which an ancient and interesting stand is described but which, since it has no chance of regeneration on account of unrestricted grazing, will probably disappear within the century. In his concluding remarks the author recommends protective measures for the Pinsapo whose great vitality is shown in the fact that it has been able to maintain itself in spite of its numerous enemies. With proper protection it would no doubt again form flourishing forests and might be used for the afforestation of other mountains in the Peninsula; this would be of great benefit to the population and to the development of agriculture.—A. R.